United States Department of Agriculture

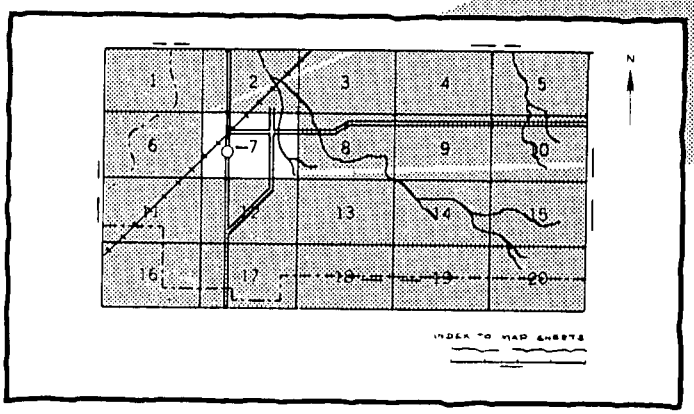
Soil Conservation Service

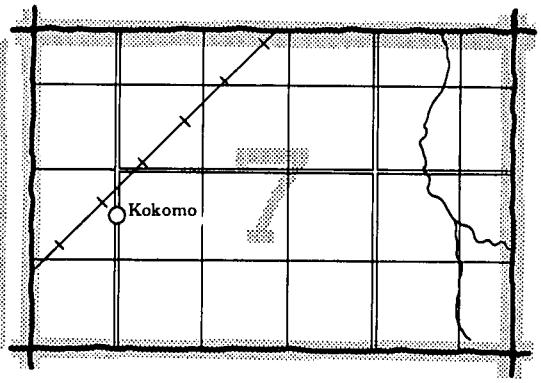
In cooperation with North Dakota Agricultural Experiment Station

Soil survey of Bottineau County North Dakota

HOW TO USE

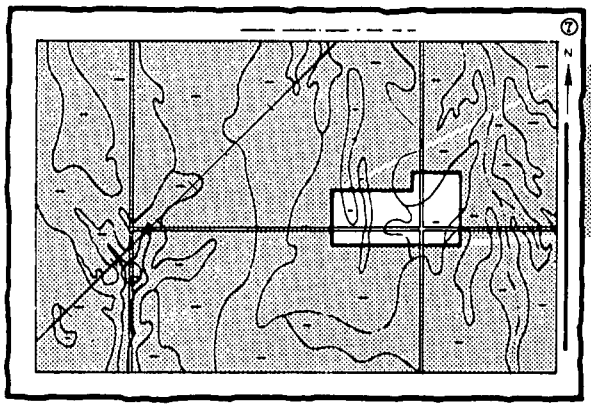
1. Locate your area of interest on the "Index to Map Sheets" (the last page of this publication).

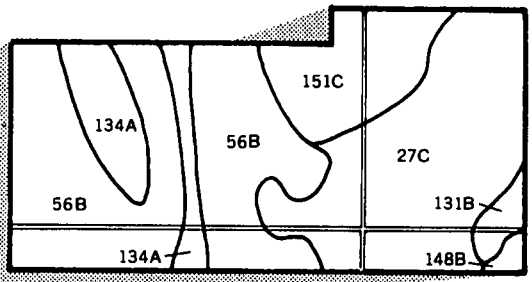




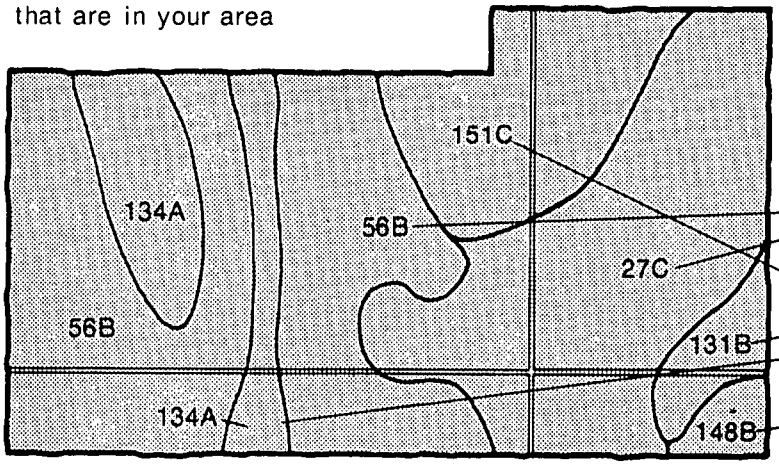
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.





4. List the map unit symbols that are in your area

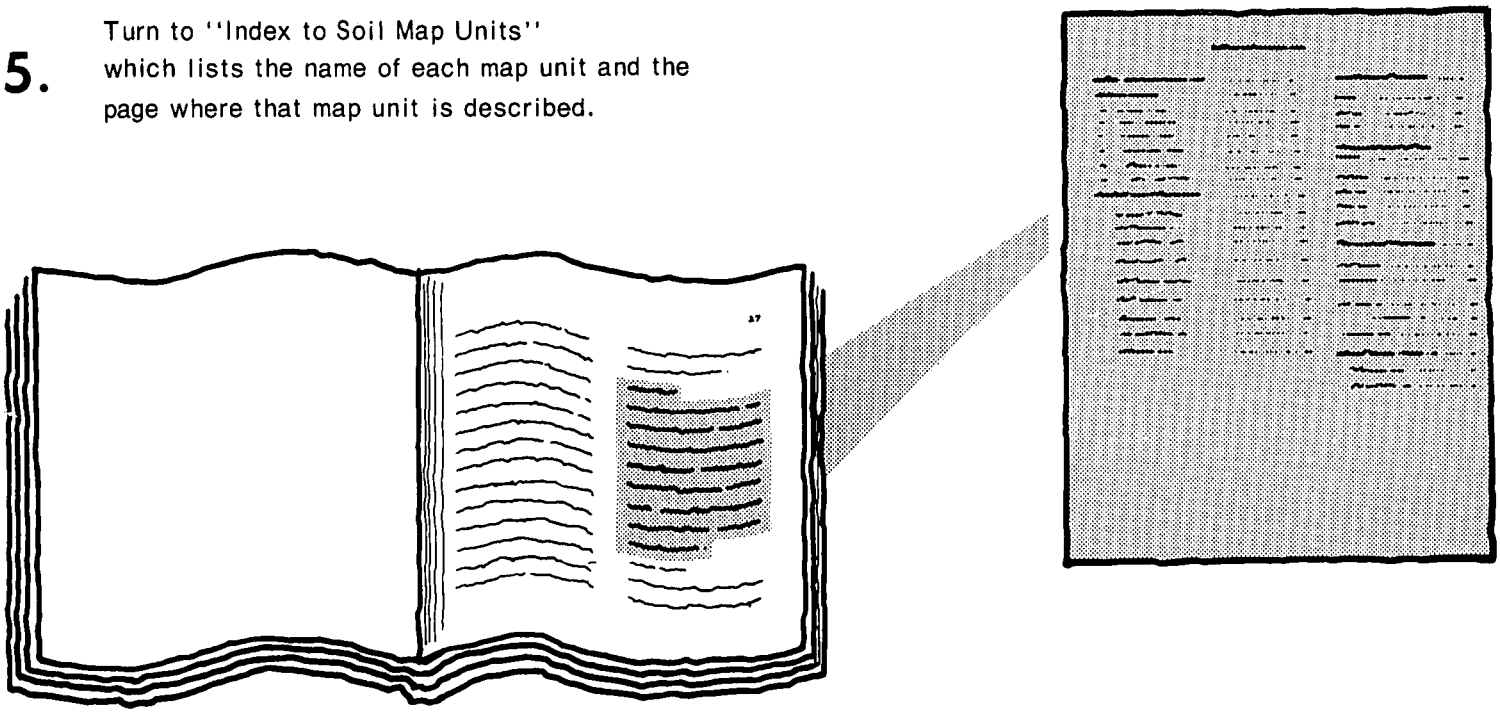


Symbols

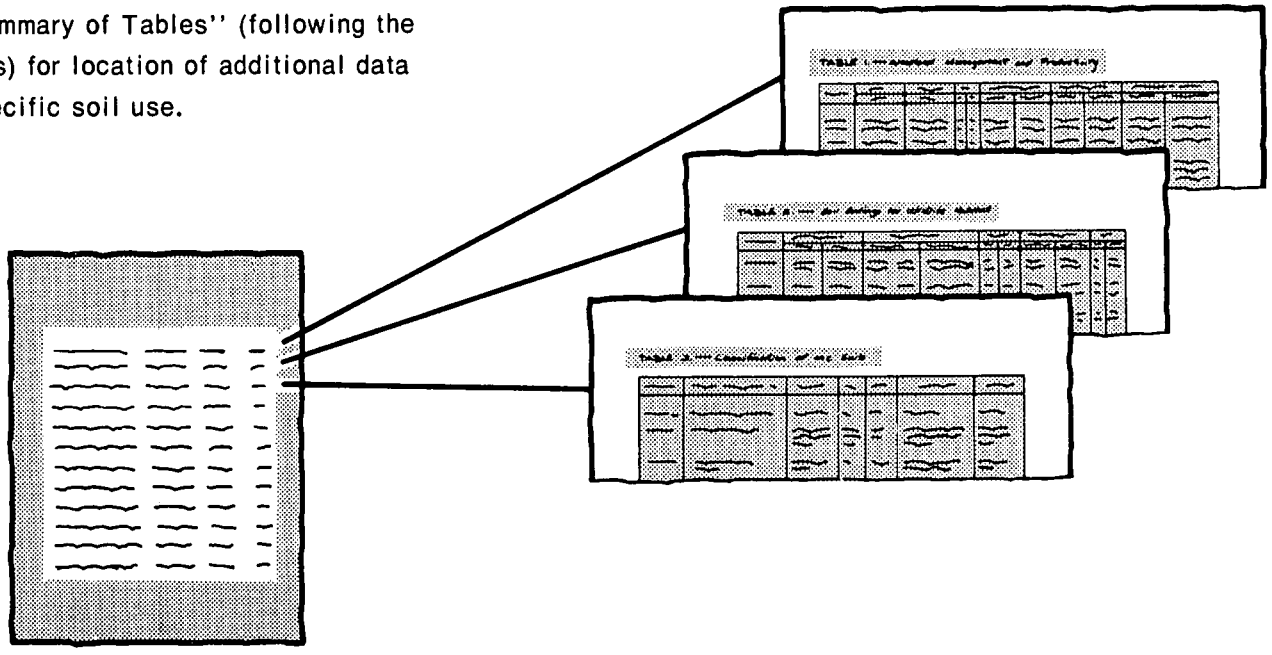
- 27C
- 56B
- 131B
- 134A
- 148B
- 151C

THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; for specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

This survey was made cooperatively by the Soil Conservation Service and the North Dakota Agricultural Experiment Station. It is part of the technical assistance furnished to the Turtle Mountain Soil Conservation District and the Mouse River Soil Conservation District. Financial assistance was provided by the Bottineau County Board of Commissioners, the Old West Regional Commission, and the North Dakota State Soil Conservation Committee.

Major fieldwork was performed in the period 1975-1980. Soil names and descriptions were approved in 1980. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1980.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

This soil survey supersedes the soil survey of Bottineau County published in 1917.

Cover: A typical area of Barnes loam, Svea loam, and Cresbard loam. These soils are used as cropland. Bottineau and Kelvin soils are in the background in the Turtle Mountains.

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soil series

Issued May 1982

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summary of tables

foreword

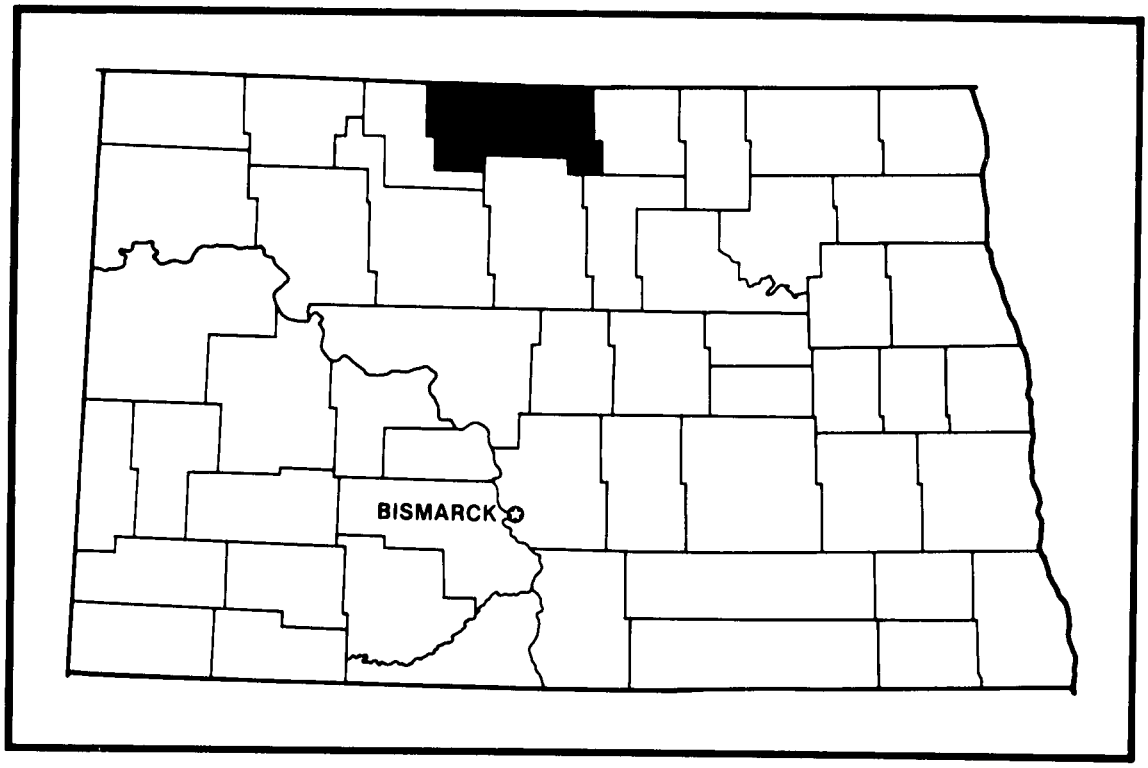
This soil survey contains information that can be used in land-planning programs in Bottineau County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations inherent in the soil or hazards that adversely affect the soil, improvements needed to overcome the limitations or reduce the hazards, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

J. Michael Nethery
State Conservationist
Soil Conservation Service



Location of Bottineau County in North Dakota.

soil survey of
Bottineau County, North Dakota

By Lynn L. DesLauriers, Soil Conservation Service

Fieldwork by Terry L. Berogan, David J. Breker, Lynn L. DesLauriers,
James H. Thiele, Steven J. Sieler, and Darrell E. VanderBusch,
Soil Conservation Service,
and Erling J. Olson and Thomas P. Ryterske,
North Dakota State Soil Conservation Committee,
and Robert L. Howey, Professional Soil Classifier

United States Department of Agriculture, Soil Conservation Service,
in cooperation with the North Dakota Agricultural Experiment Station

BOTTINEAU COUNTY is in the north-central part of North Dakota. It has an area of 1,092,480 acres or 1,707 square miles. Bottineau is the county seat.

The county is in the Drift Prairie Region Border vegetative zone of North Dakota. It is in the Northern Black Glaciated Plains area of the Northern Great Plains Spring Wheat Region (*3*). The soils formed mainly in material that weathered from glacial till, glacial lacustrine deposits, and glacial outwash sediment. Most of the county is a nearly level to undulating prairie, except for the Turtle Mountains, which consist of undulating to hilly knolls and ridges (fig. 1). The Souris River (known in North Dakota as the Mouse River) flows in a northerly direction through the center of the county. All creeks and tributaries drain into the Souris River.

Except in the Turtle Mountains, the elevation ranges from about 1,410 feet on the Souris River at the Canadian border to 1,650 feet on the northern edge of Bottineau. Boundary Butte, the highest point in the Turtle Mountains, has an elevation of 2,451 feet, and Lake Metigoshe is at 2,138 feet.

About 70 percent of the acreage in Bottineau County is used for crops. The only large areas of native grassland are along the breaks of the Souris River and along the southern and western edge of the Turtle Mountains. Most of the native woodland is in the Turtle Mountains, which make up about 10 percent of the county.

general nature of the county

This part of the survey provides general information on the climate, settlement, farming, and natural resources of Bottineau County.

climate

Prepared by the National Climatic Center, Asheville, North Carolina.

Bottineau County usually is quite warm in summer. There are frequent spells of hot weather and occasional cool days. Winters are very cold; arctic air frequently surges over the area. Most precipitation falls in the warm period. Precipitation normally is heaviest late in spring and early in summer. Winter snowfall normally is not too heavy, and the snow is blown into drifts so that much of the ground is free of snow.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Bottineau, North Dakota, in the period 1951 to 1974. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 6 degrees F, and the average daily minimum temperature is -5 degrees. The lowest temperature on record, which occurred at Bottineau on January 4, 1968, is -43 degrees. In summer

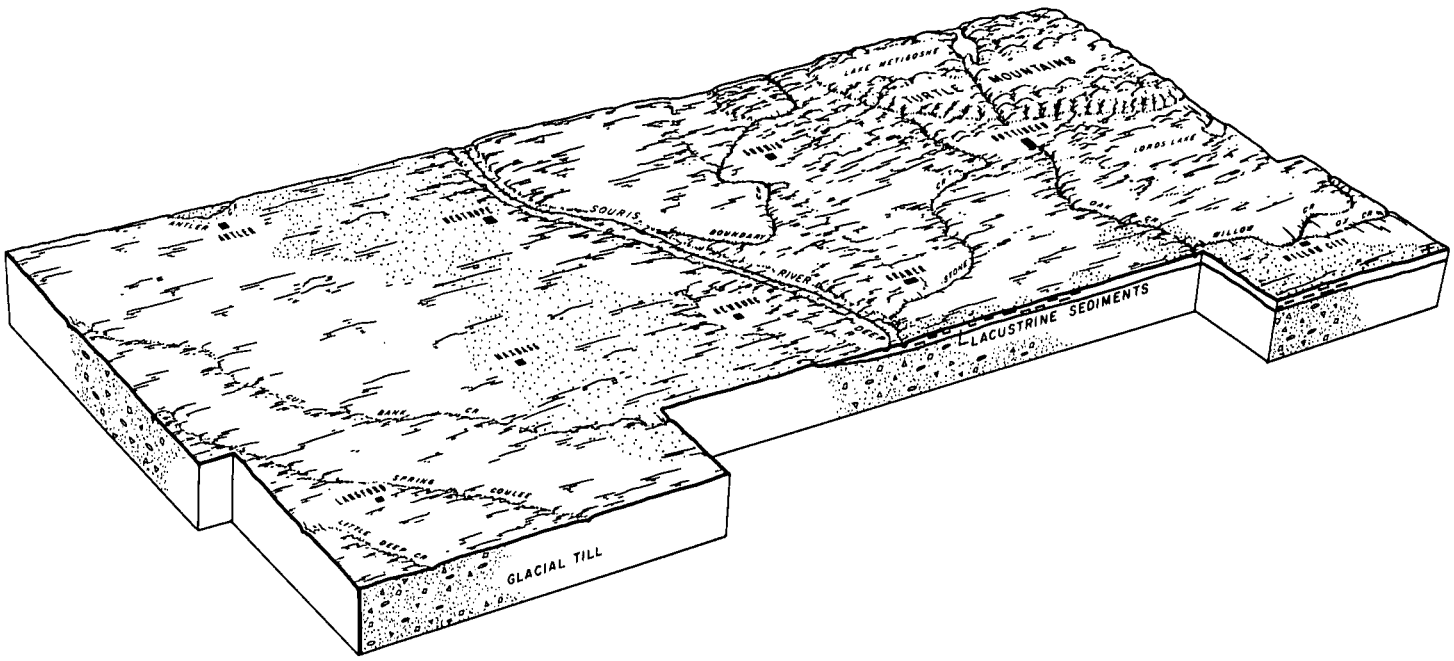


Figure 1.—Drainage and relief of Bottineau County.

the average temperature is 65 degrees, and the average daily maximum temperature is 78 degrees. The highest recorded temperature, which occurred at Bottineau on August 9, 1958, is 103 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 17.5 inches. Of this, 14 inches, or 80 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 10 inches. The heaviest 1-day rainfall during the period of record was 5.03 inches at Bottineau on September 2, 1973. Thunderstorms occur on about 30 days each year, and most occur in summer.

The Turtle Mountains receive a significantly larger amount of precipitation than is normal for the rest of Bottineau County. Manitoba Department of Transport records collected at the Peace Garden for the period 1967 to 1970 show an average annual precipitation of 27.78 inches in the mountain area. In this same period of Bottineau, the U.S. National Weather Service recorded an average annual precipitation of 17.88 inches.

The average seasonal snowfall is 31 inches. The greatest snow depth at any one time during the period of record was 37 inches. On an average of 63 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year.

Several times each winter, storms in the area bring blizzard conditions with snow and high winds. Hail occurs in small, scattered areas during summer thunderstorms.

The average relative humidity in midafternoon is about 55 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the southwest. Average windspeed is highest, 11 miles per hour, in spring.

settlement

Bottineau County was established by an act of the Dakota Territorial Legislation on January 4, 1873.

Settlement of the county began about 1883. Some of the earliest settlements were made near Overly, along Antler Creek, between St. Paul Butte and Lord's Lake, and at a site that was called Old Bottineau (*5*). Bottineau was selected as the county seat in 1884. In 1886, the railroad was extended from Devils Lake into Bottineau County. The Old Bottineau settlement moved to a new site along the railroad.

In 1885, the population of Bottineau County was 818. By 1910, the population had reached a peak of 17,295. In 1970, the population was 9,496 (*4*).

farming

Farming is the most important industry in Bottineau County. In 1900, there were 1,966 farms. That number

increased to 2,304 farms in 1910. In recent years the number of farms has decreased from 1,805 in 1950 to 1,192 in 1974. The Mouse River and Turtle Mountain Soil Conservation Districts were organized in 1940 (*4*).

The main crops grown in Bottineau County are hard red spring wheat and durum wheat. Other important crops are flax, barley, oats, and rye. Sunflowers are an increasingly important cash crop. For the most part, sunflowers are grown for oil production. Alfalfa is an important feed crop.

Raising livestock is a minor enterprise in Bottineau County. Most of the livestock are beef cattle, but there are a few dairy herds.

natural resources

Soil is the most important natural resource in the county. Crops and livestock are marketable products that derive ultimately from the soil.

There are no commercial deposits of lignite coal in Bottineau County. Oil was first discovered in Bottineau County in 1952. Scattered oil fields are now in production in the western half of the county. They include fields near Westhope, Newburg, Souris, and Maxbass. There are also some producing wells near Lansford.

As a result of glaciation, there are several areas of sandy and gravelly outwash material in the county where these deposits are suitable for commercial use.

The only extensive aquifers are along the fringes of the Turtle Mountains and in the Antler Creek area.

Stands of native timber in Bottineau County are cut to some extent for rough lumber and fence posts. More commonly, the wood is used as fuel.

Some peat is dug in the Turtle Mountains and is sold commercially.

how this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map units" and "Detailed soil map units."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, rangeland and woodland managers, engineers, planners, developers and builders, home buyers, and others.

The first soil survey of Bottineau County was published in 1910 (*6*). A second, more detailed soil survey was published in 1917 (*7*). This survey supersedes the earlier surveys. It provides additional information and has larger maps that show the soils in more detail.

general soil map units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Deep, fine textured to moderately coarse textured, level to gently rolling soils on uplands

The soils making up this group formed in till, lacustrine deposits, glacial outwash, and eolian sediment over till or lacustrine deposits. They make up about 79 percent of the county. The major soils are used mainly for cultivated crops.

1. Barnes association

Well drained, level to undulating, medium textured soils that formed in till

This association consists of large smooth areas and a few slight knolls on till plains adjacent to stream channels. Runoff flows to the stream channels. Slope ranges from 0 to 6 percent.

This association makes up about 2 percent of the county. It is about 80 percent Barnes soils and 20 percent minor soils.

Barnes soils are well drained. They are level to undulating and are in smooth areas and on slight knolls. They have a surface layer of black loam and a subsoil of dark brown loam.

The minor soils in this association are the somewhat excessively drained Arvilla soils in positions similar to those of Barnes soils and the poorly drained Colvin soils adjacent to stream channels.

The soils in this association are used mainly for farming. Preventing excessive soil loss by erosion is the major concern in management. Barnes soils are well suited to cultivated crops, pasture, and windbreaks. They are suited to use as building sites and septic tank absorption fields. Of the minor soils, Arvilla soils are used mainly for crops and Colvin soils are used mainly for hay and pasture.

2. Barnes-Svea association

Well drained and moderately well drained, level to undulating, medium textured soils that formed in till

This association consists of slight knolls, swales, and flats on till plains. Depressions are scattered throughout, and runoff collects in them. Slope ranges from 0 to 6 percent.

This association makes up about 38 percent of the county. It is about 55 percent Barnes soils and 17 percent Svea soils (fig. 2). The remaining 28 percent is minor soils.

Barnes soils are well drained. They are level to undulating and are on slight knolls. They have a surface layer of black loam and a subsoil of dark brown loam.

Svea soils are moderately well drained. They are level and nearly level and are in swales and flats. They have a surface layer of black loam and a subsoil of very dark gray and dark brown loam. The subsoil is mottled in the lower part.

The minor soils in this association are the well drained Buse soils on knobs, the poorly drained Tonka and the very poorly drained Parnell soils in depressions, and the somewhat poorly drained Hamerly soils around and between depressions.

The soils in this association are used mainly for farming. The major concern in management is preventing excessive soil loss by erosion. The major soils are well suited to crops, pasture, and windbreaks. They are suited to use as building sites and septic tank absorption fields. Among the minor soils, Tonka and Parnell soils are used mainly for hay and as habitat for wetland wildlife, and Hamerly soils are used mainly for crops.

3. Embden-Swenoda-Gardena association

Moderately well drained, level and nearly level, moderately coarse textured and medium textured soils that formed in glacial outwash, lacustrine deposits, and eolian sediment over till or lacustrine deposits

This association consists of large flats that include scattered low areas and shallow depressions on glacial lacustrine plains. Most of the precipitation is absorbed by the soils. The limited runoff collects in the depressions. Slope ranges from 0 to 3 percent.

This association makes up about 13 percent of the county. It is about 26 percent Embden soils, 22 percent Swenoda soils, and 15 percent Gardena soils. The remaining 37 percent is minor soils.

Embden soils are on flats. They have a surface layer of very dark gray fine sandy loam and a subsoil of very dark brown and very dark grayish brown fine sandy loam.

Swenoda soils are on flats. They have a surface layer of black fine sandy loam and a subsoil of dark grayish brown fine sandy loam.

Gardena soils are on flats. They have a surface layer of black silt loam and a subsoil of black and very dark grayish brown silt loam.

The minor soils in this association are the somewhat poorly drained Glyndon and Wyndmere soils in low areas and the poorly drained Arveson and Stirum soils in depressions.

The soils in this association are used mainly for farming. The major concern in management is preventing excessive soil loss from soil blowing. The major soils are well suited to crops, pasture, and windbreaks. They are suited to use as building sites and septic tank absorption fields. Of the minor soils, Arveson and Stirum soils are used for hay and as habitat for wetland wildlife. Glyndon and Wyndmere soils are used mainly for crops.

4. Gardena-Aberdeen-Overly association

Moderately well drained, level and nearly level, medium textured and moderately fine textured soils that formed in lacustrine deposits

This association consists of large flats and scattered low-lying areas on glacial lacustrine plains. Runoff collects in the low-lying areas. Slope ranges from 0 to 3 percent.

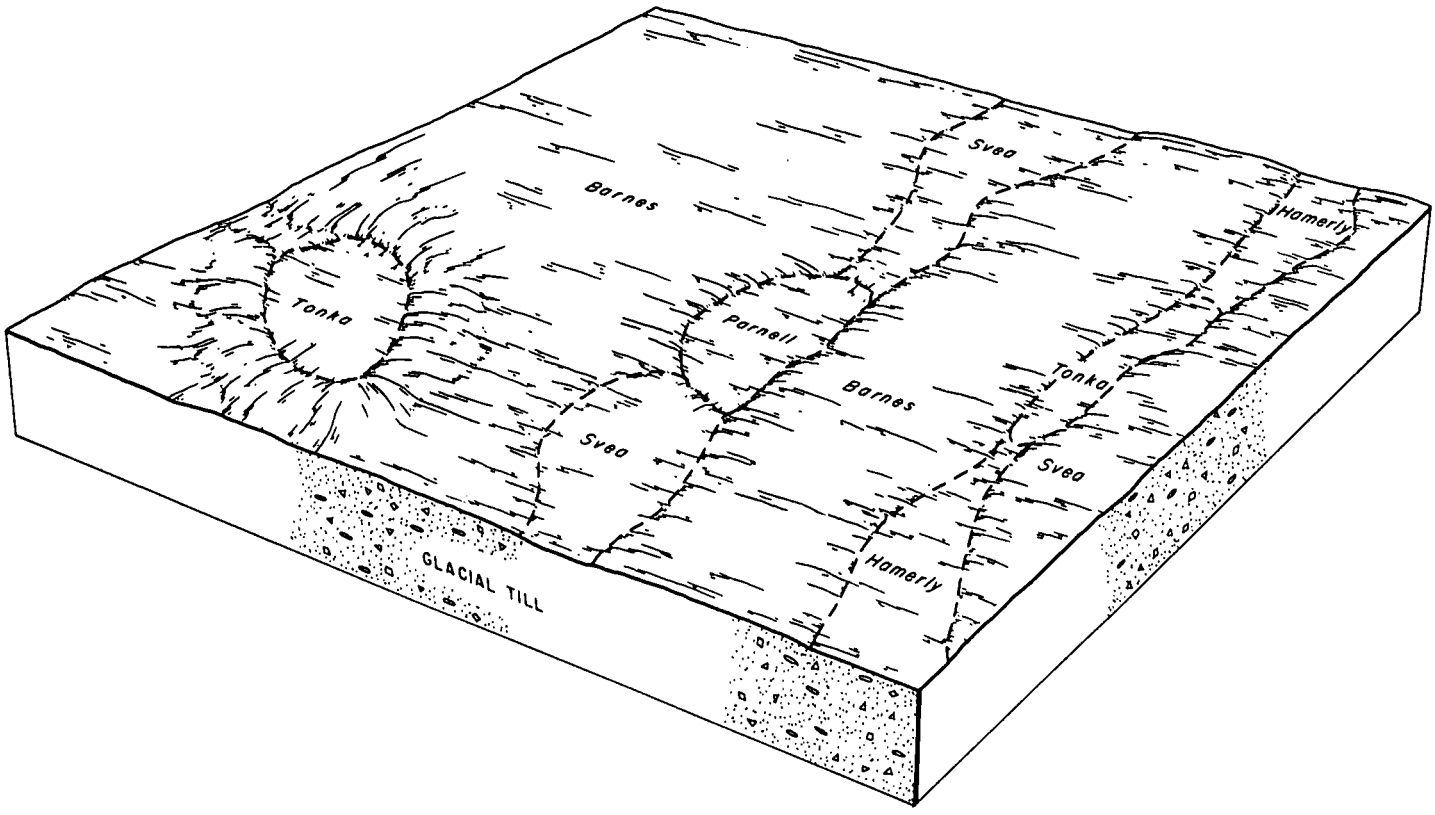


Figure 2.—Typical pattern of soils and underlying material in the Barnes-Svea association.

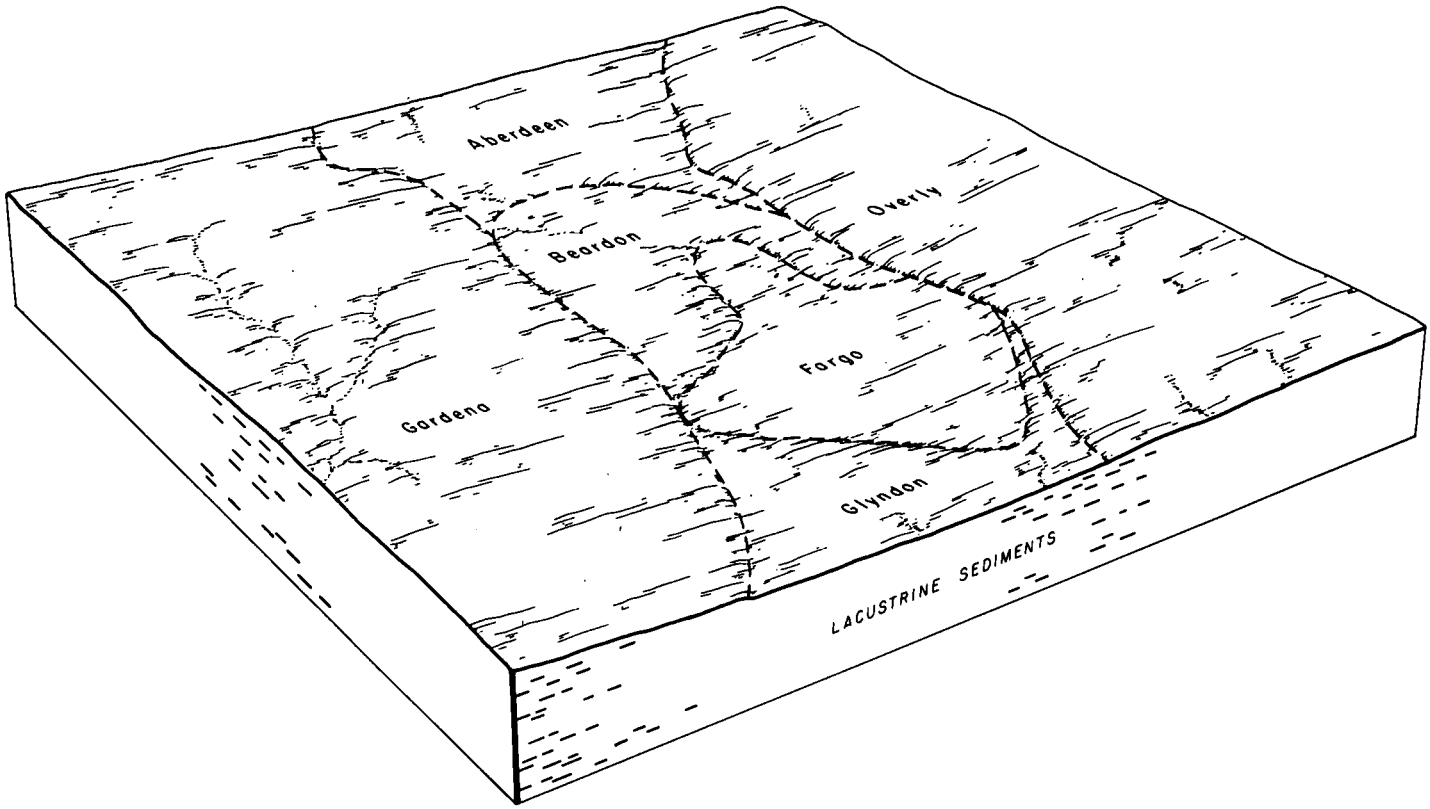


Figure 3.—Typical pattern of soils and underlying material in the Gardena-Overly-Fargo association.

This association makes up about 7 percent of the county. It is about 23 percent Gardena soils, 22 percent Aberdeen soils, and 18 percent Overly silty clay loam. The remaining 37 percent is minor soils.

Gardena soils are on flats. They have a surface layer of black silt loam and a subsoil of black and very dark grayish brown silt loam.

Aberdeen soils are on flats. They have a surface layer of black silt loam and a subsoil of black and very dark grayish brown silty clay loam.

Overly soils are on flats. They have a surface layer of black silty clay loam and a subsoil of dark brown silty clay loam.

The minor soils in this association are the well drained Eckman soils on slight knolls, the moderately well drained Embden soils on flats, and the somewhat poorly drained Glyndon, Bearden, and Exline soils in low areas.

The soils in this association are used mainly for farming. The major concerns in management are preventing excessive soil loss by erosion and maintaining soil tilth. The major soils are well suited to crops and pasture and suited to windbreaks. They are suited to use as building sites and septic tank absorption fields, except for Aberdeen soils, which are poorly suited to use as septic tank absorption fields. Of the minor soils, Embden, Eckman, Glyndon, and Bearden soils are used for crops, and Exline soils are used for pasture or hay.

5. Gardena-Overly-Fargo association

Moderately well drained and poorly drained, level and nearly level, medium textured to fine textured soils that formed in lacustrine deposits

This association consists of large flats and low-lying areas on glacial lacustrine plains. Runoff collects in the low-lying areas. Slope ranges from 0 to 3 percent.

This association makes up about 9 percent of the county. It is about 27 percent Gardena soils, 26 percent Overly soils, and 14 percent Fargo soils (fig. 3). The remaining 33 percent is minor soils.

Gardena soils are on flats. They have a surface layer of black silt loam and a subsoil of black and very dark grayish brown silt loam.

Overly soils are on flats. They have a surface layer of black silty clay loam and a subsoil of dark brown silty clay loam.

Fargo soils are in low-lying areas. They have a surface layer of black silty clay and a subsoil of black and dark grayish brown silty clay.

The minor soils in the association are the well drained Eckman and Great Bend soils in slightly higher convex areas and low knolls, the moderately well drained Aberdeen soils on flats, and the somewhat poorly drained Glyndon and Bearden soils in low areas.

The soils in this association are used mainly for farming. The major concerns in management are maintaining soil tilth and controlling soil erosion. Also, surface water needs to be removed from the Fargo soil. The major soils are well suited to crops, pasture, and windbreaks. Gardena and Overly soils are suited to use as building sites and septic tank absorption fields, but Fargo soils are poorly suited to these uses. The minor soils are used mainly as cropland.

6. Barnes-Svea-Cresbard association

Well drained and moderately well drained, level to gently rolling, medium textured soils that formed in till

This association consists of knolls, ridges, swales, and flats on till plains. Depressions are scattered throughout. Runoff collects in the depressions. Slope ranges from 0 to 9 percent.

This association makes up about 10 percent of the county. It is about 21 percent Barnes soils, 20 percent Svea soils, and 19 percent Cresbard soils. The remaining 40 percent is minor soils.

Barnes soils are well drained. They are in level to gently rolling slightly convex areas and on knolls and ridges. They have a surface layer of black loam and a subsoil of dark brown loam.

Svea soils are moderately well drained. They are on level and nearly level swales and flats. They have a surface layer of black loam and a subsoil of very dark gray and dark brown loam. The subsoil is mottled in the lower part.

Cresbard soils are moderately well drained. They are on level to undulating flats and slight knolls. They have a surface layer of black loam and a subsoil of very dark gray and very dark grayish brown clay loam.

The minor soils in this association are the somewhat poorly drained Exline and Hamerly soils in low areas, the well drained Buse soils on the crest of knolls and ridges, and the moderately well drained Embden soils on flats and in swales.

The soils in this association are used mainly for farming. The main concern in management is preventing excessive soil loss by erosion. The major soils are suited to crops and windbreaks and are well suited to pasture. They are suited to use as sites for buildings and as septic tank absorption fields. Among the minor soils, Exline soils are used for pasture or hay. Hamerly and Embden soils are used mainly for crops, and Buse soils are used for crops except for some places where they are used for pasture and hay.

Deep, medium textured, gently sloping to hilly soils on uplands

The soils making up this group formed in till. They make up about 10 percent of the county. The major soils in this group are used mainly as woodland and wildlife habitat and for recreation, but in some places they are used for cultivated crops.

7. Kelvin association

Well drained, gently sloping to moderately steep, medium textured soils that formed in till

This association consists of knolls, hills, and ridges on till plains. Depressions and water areas are scattered throughout. Runoff collects in depressions and lakes. Slope ranges from 3 to 25 percent.

This association makes up about 7 percent of the county. It is about 69 percent Kelvin soils and 31 percent minor soils and water (fig. 4).

Kelvin soils are well drained. They are on gently sloping to moderately steep knolls, hills, and ridges. They have a surface layer of very dark grayish brown loam and a subsoil that is very dark grayish brown clay in the upper part and mottled, very dark grayish brown and dark brown clay loam in the lower part.

The minor soils in this association are the moderately well drained Rolla soils on flats and in slightly convex areas and the very poorly drained Eramosh soils in depressions.

The soils in this association are mainly in native woodland. The main concern in management, where the soils have been cleared and cultivated, is protecting the soil from excessive soil loss by erosion. Kelvin soils are poorly suited to crops. They are suited to pasture and windbreaks. They are also suited to use as sites for buildings and as septic tank absorption fields. Of the minor soils, Rolla soils are used as cropland, and Eramosh soils are used for pasture and hay and as habitat for wetland wildlife.

8. Bottineau-Buse association

Well drained, undulating to hilly, medium textured soils that formed in till

This association consists of knolls, hills, and ridges on till plains. Depressions and water areas are scattered throughout. Runoff collects in depressions and lakes and flows to streams. Slope ranges from 3 to 25 percent.

This association makes up about 3 percent of the county. It is about 75 percent Bottineau soils and 15

percent Buse soils. The remaining 10 percent is minor soils and water areas.

Bottineau soils are well drained. They are on undulating to hilly knolls, hills, and ridges. They have a surface layer of black loam and a subsoil that is very dark grayish brown clay loam in the upper part and grayish brown loam in the lower part.

Buse soils are well drained. They are on the top of undulating to hilly knolls, hills, and ridges. They have a surface layer of very dark gray loam and an underlying material that is dark grayish brown loam in the upper part and brown and grayish brown clay loam in the lower part.

The minor soils in this association are the well drained Barnes soils on lower plane and convex slopes and the very poorly drained Eramosh soils in depressions.

The soils in this association are mainly native woodland and are used as pasture. The main concern in management is maintaining vigor of the vegetation and preventing excessive soil loss by erosion. The major soils are poorly suited to crops and windbreaks. They are suited to pasture. They are also suited to use as building sites and septic tank absorption fields. Of the minor soils, Eramosh soils are used as pasture, hayland, and habitat for wetland wildlife.

Deep, medium textured, level, sodium-affected soils on uplands

The soils making up this group formed in lacustrine deposits. They make up about 1 percent of the county. The major soils in this group are used for pasture and hay.

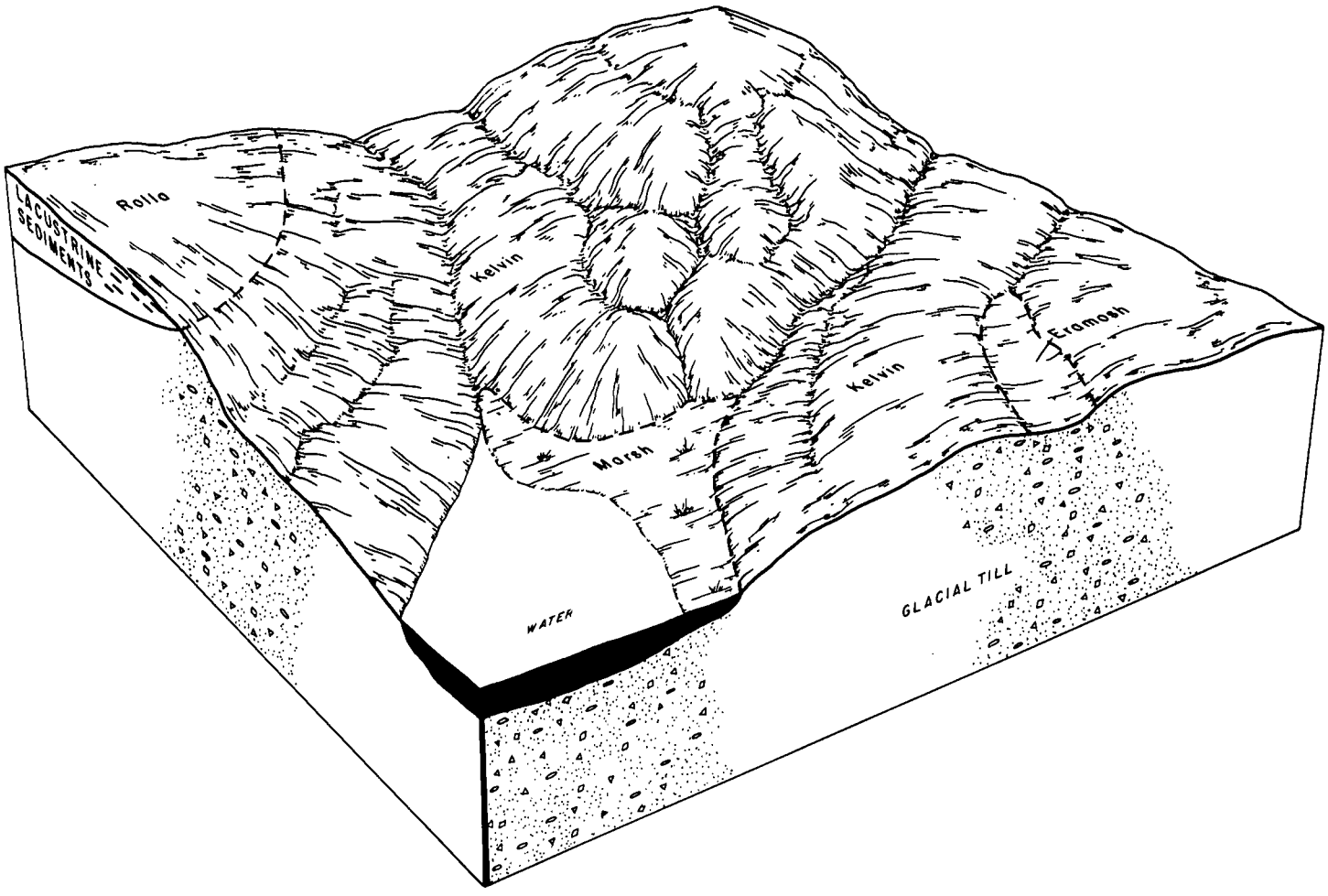


Figure 4.—Typical pattern of soils and the underlying material in the Kelvin association.

9. Exline-Aberdeen association

Somewhat poorly drained and moderately well drained, level, medium textured soils that formed in lacustrine deposits

This association consists of flats and low areas on glacial lacustrine plains and alluvial plains of streams. Runoff flows to stream channels. Slope ranges from 0 to 1 percent.

This association makes up about 1 percent of the county. It is about 48 percent Exline soils and 30 percent Aberdeen soils. The remaining 22 percent is minor soils.

Exline soils are somewhat poorly drained. They are in low areas. They have a surface layer of very dark gray silt loam and a subsoil of very dark gray, dark grayish brown, and very dark grayish brown silty clay loam.

Aberdeen soils are moderately well drained. They are on flats. They have a surface layer of black silt loam and a subsoil of black and very dark grayish brown silty clay loam.

The minor soils in this association are the moderately well drained Overly soils on flats.

The soils in this association are used mainly as pasture or hayland. The main concern in management is maintaining vigor of the pasture plants and preventing excessive soil loss by erosion. The major soils are poorly suited to crops and windbreaks, but they are suited to use as pasture. They are poorly suited to use as sites for buildings and septic tank absorption fields. The minor Overly soils are used mainly for crops.

Deep, coarse textured to medium textured, level to rolling soils on uplands

The soils making up this group formed in glacial outwash and stratified alluvium. They make up about 9 percent of the county. The major soils in this group are used mainly for cultivated crops, but in some places they are used as pasture.

10. Arvilla-Sioux-Divide association

Somewhat excessively drained, excessively drained, and somewhat poorly drained, level to rolling, moderately coarse textured and medium textured soils that formed in glacial outwash and stratified alluvium

This association consists of dissected outwash plains, or large flats, knolls, and ridges adjacent to drainageways. A few low areas and slight depressions are scattered throughout. Most of the precipitation is absorbed by the soil, and the limited runoff flows to the drainageways and collects in depressions. Slope ranges from 0 to 15 percent.

This association makes up about 3 percent of the county. It is about 35 percent Arvilla soils, 22 percent Sioux soils, and 15 percent Divide soils. The remaining 28 percent is minor soils.

Arvilla soils are somewhat excessively drained. They are on level to undulating flats and low knolls and ridges. They have a surface layer of black sandy loam and a subsoil of very dark gray sandy loam.

Sioux soils are excessively drained. They are on level flats to rolling knolls and ridges. They have a surface layer of black loam; the underlying material is dark brown gravelly sand.

Divide soils are somewhat poorly drained. They are in low areas. The surface layer is black loam, and the underlying material is light gray, gray, and very dark grayish brown loam in the upper part and dark yellowish brown gravelly sand in the lower part.

Minor soils in this association are the poorly drained Colvin and Marysland soils in slight depressions.

The soils in this association are used mainly for farming, but in some places they are used for pasture and hay. The main concern in management is preventing excessive soil loss from erosion. The major soils are poorly suited to crops and windbreaks, but they are suited to pasture. They are suited to use as building sites and poorly suited to use as septic tank absorption fields. Marysland and Colvin soils are used mainly for pasture and hay and as habitat for wetland wildlife.

11. Hecla-Ulen association

Moderately well drained and somewhat poorly drained, level to undulating, coarse textured soils that formed in sandy glacial outwash

This association consists of flats and swales and a few hummocky areas on glacial lacustrine and outwash plains. Depressions are scattered throughout. Runoff water collects in the depressions. Slope ranges from 0 to 6 percent.

This association makes up about 6 percent of the county. It is about 53 percent Hecla soils and 19 percent Ulen soils. The remaining 28 percent is minor soils (fig. 5).

Hecla soils are moderately well drained. They are level to undulating and are on flats and small knobs. They have a surface layer of black loamy fine sand and underlying material that is very dark grayish brown loamy fine sand in the upper part and dark grayish brown fine sand in the lower part. The underlying material is mottled from a depth of 39 to 48 inches.

Ulen soils are somewhat poorly drained. They are in swales. The surface layer is black loamy fine sand, and the underlying material is dark gray and mottled dark brown loamy fine sand in the upper part and mottled yellowish brown and mottled light olive brown fine sand in the lower part.

The minor soils in this association are the poorly drained Arveson and Stirum soils in depressions and the somewhat poorly drained Wyndmere soils in low areas.

The soils in this association are used mainly for farming, but in some places they are used for pasture

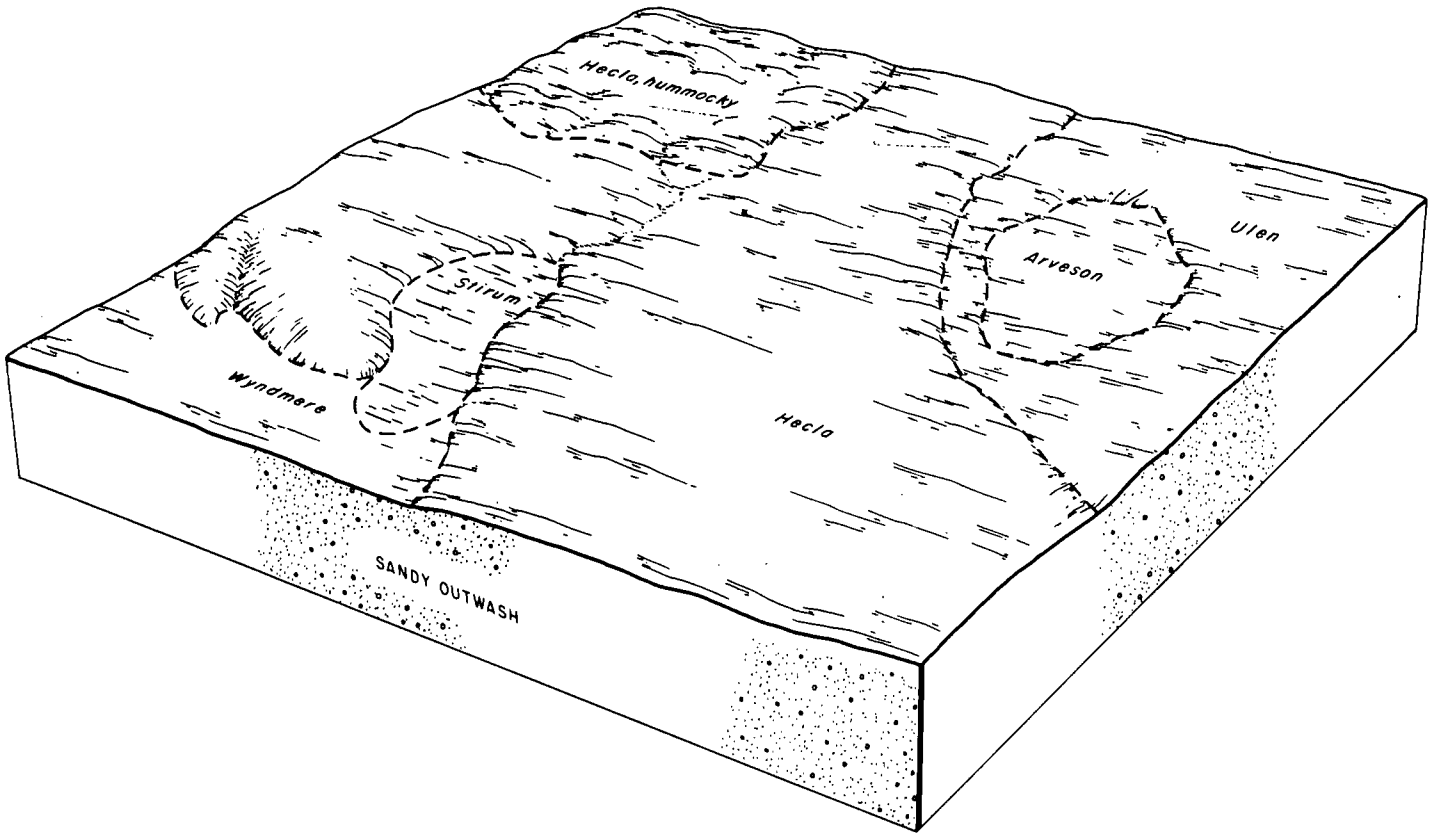


Figure 5.—Typical pattern of soils and underlying material in the Hecla-Ulen association.

and hay. The main concerns in management are preventing excessive soil loss by soil blowing and maintaining the vigor of the pasture plants. The soils are poorly suited to crops, but they are well suited to use as pasture and to trees in windbreaks. The soils are suited to building site development, but they are poorly suited to use as septic tank absorption fields. Of the minor soils, Arveson and Stirum soils are used mainly for hay and pasture and as habitat for wetland wildlife, and Wyndmere soils are used mainly as cropland.

Deep, moderately fine textured, level soils on bottom lands

The soils making up this group formed in water-sorted sediment. They make up about 1 percent of the county. The major soils in this group are used as habitat for wetland wildlife.

12. Parnell association

Very poorly drained, level, moderately fine textured soils that formed in water-sorted sediment

This association consists of soils on the flood plain of the Souris River (fig. 6). Slope ranges from 0 to 1 percent.

This association makes up about 1 percent of the county. It is about 87 percent Parnell soils and 13 percent minor soils and water areas.

Parnell soils are very poorly drained. They are on level flood plains. They have a surface layer of black silty clay loam and a subsoil of black and very dark gray silty clay.

The minor soils in this association are the well drained Barnes and Buse soils. They are on slopes and breaks adjacent to the flood plain.

The soils in this association are used as habitat for wetland wildlife. The main concern in management is maintaining the vigor of the wetland plants and protecting the soils from siltation. Parnell soils are not suited to crops, pasture, windbreaks, buildings, and septic tank absorption fields. Barnes and Buse soils are used mainly as pasture and habitat for openland wildlife.

broad land use considerations

The North Dakota Agricultural Statistics, No. 45, of 1980 show that about 36 percent of the land in Bottineau County is used for small grains and 10 percent for row crops; 20 percent is summer fallow and 4 percent is used for flaxseed and 2 percent for hay; and 28 percent is in other uses, for example, woodland, recreation, and urban uses. The general soil map is

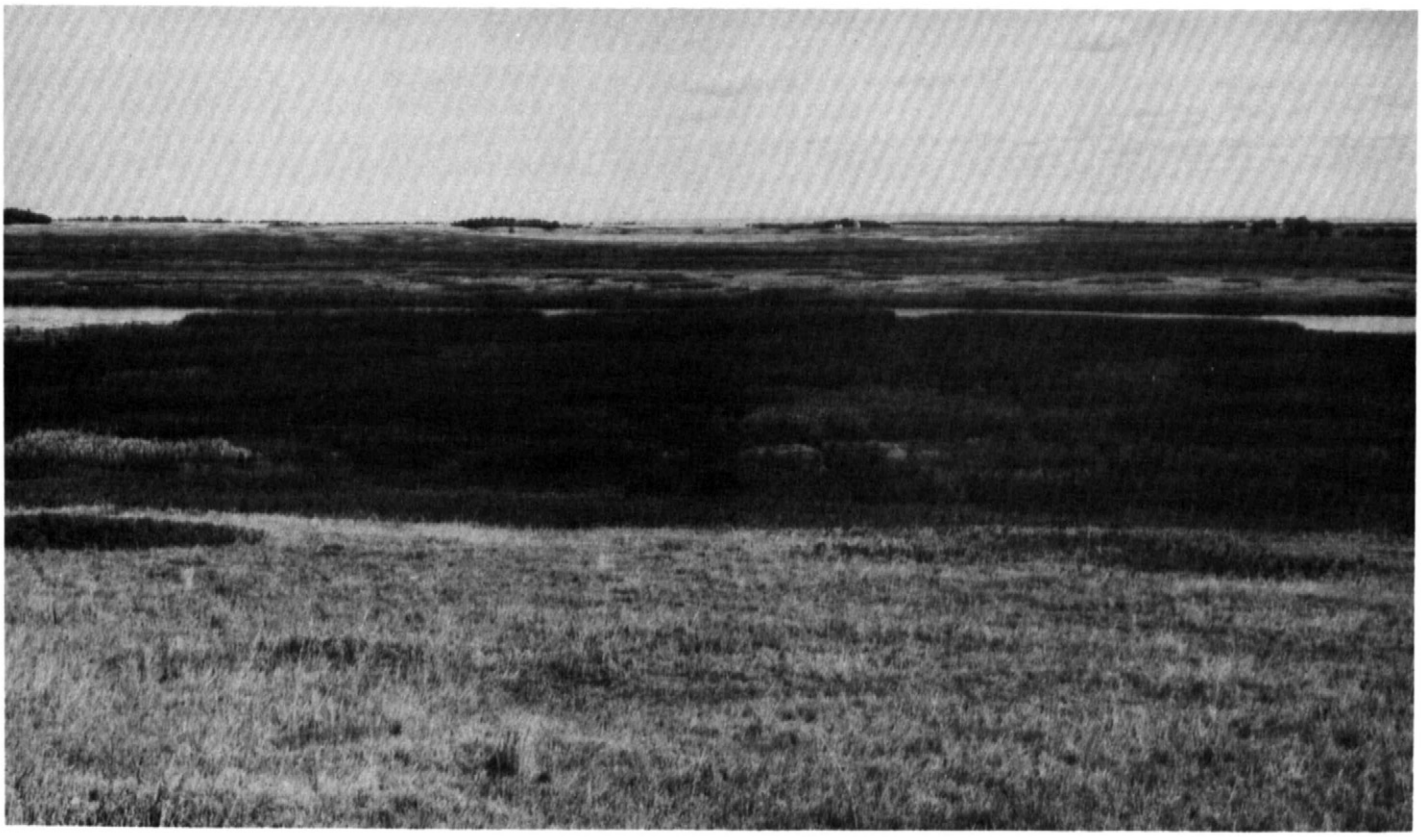


Figure 6.—Parnell soils on the flood plain of the Souris River.

helpful in making large-scale plans as to which land should be used for urban and industrial development and which should be used as cropland and pasture. The map cannot be used, however, for the selection of sites for particular urban and industrial structures. In general, the soils that are well suited to cultivated crops are also well suited to urban and industrial development.

The Parnell association is the only one in which the soils, which are almost continuously ponded, are so unfavorable that urban development is precluded. The Exline-Aberdeen association is limited for urban uses by the sodic nature of the soils, wetness, and salinity. The soils in the Arvilla-Sioux-Divide association and the Hecla-Ulen association are rapidly permeable. Because of the poor filtering characteristics of the soils, effluent from septic tank absorption fields can pollute the ground water. All the associations include small areas of soils that are poorly drained and very poorly drained. Generally, these soils are so wet that they are not suited to urban uses.

The Gardena-Overly-Fargo, Barnes-Svea, Barnes, Embden-Swenoda-Gardena, and Gardena-Aberdeen-Overly associations are well suited to cultivated crops. The associations least suited to cultivated crops are the Kelvin and Bottineau-Buse associations, which are limited by steepness of slopes; the Hecla-Ulen and Arvilla-Sioux-Divide associations, which are limited by droughtiness and a severe hazard of soil blowing; the Exline-Aberdeen association, which is limited by excess sodium and salinity; and the Parnell association, which is limited by ponded surface water.

detailed soil map units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil, and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Barnes loam, 0 to 3 percent slopes, is one of several phases in the Barnes series.

Some map units are made up of two or more major soils. These map units are called soil complexes or undifferentiated groups.

A *soil complex* consists of two or more soils that occur as areas so intricately mixed or so small that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Hamerly-Tonka complex, 0 to 3 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in a mapped area are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Glyndon and Bearden soils, saline, is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. These dissimilar soils are described in each map unit. Also, some of the more unusual or strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes some *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, gravel, is an example. Some miscellaneous areas are large enough to be delineated on the soil maps. Some that are too small to be delineated are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

soil descriptions

1—Tonka silt loam. This is a level, poorly drained soil in shallow depressions on till and lacustrine plains. It is frequently ponded during snowmelt and occasionally ponded during periods of heavy rainfall. The areas range from 3 to 20 acres in size.

Typically, the surface layer is very dark gray silt loam about 10 inches thick. The subsurface layer is 10 inches thick. It is very dark gray silt loam in the upper part and dark gray silty clay loam in the lower part. The subsoil is very dark grayish brown silty clay about 14 inches thick. The underlying material to a depth of about 60 inches is clay loam. It is dark grayish brown in the upper part and grayish brown in the lower part. The subsurface layer, the subsoil, and the underlying material are mottled.

Included with this soil in mapping are very poorly drained Parnell soils in small areas in the deepest part of the depressions. The included soils make up about 10 percent of the map unit.

Permeability is slow. Runoff is ponded. Soil tilth is good. The content of organic matter is high. The

available water capacity is high. A seasonal water table is above or near the surface.

In most areas, this soil is farmed, but in some areas, it is used for hay or pasture or as habitat for wetland wildlife. If it is drained, this soil is suited to small grains, flax, and sunflowers. In the undrained areas, ponded surface water frequently delays or prevents tilling and seeding. Nevertheless, crops are grown in most years. Soil blowing is a slight hazard and is easily controlled by tillage that leaves crop residue on the surface.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil, if it is undrained, generally is not suited to trees and shrubs in windbreaks and as environmental plantings. If the soil is adequately drained, climatically adapted species of trees and shrubs grow well.

This soil is well suited to use as habitat for wetland wildlife. Most areas are surrounded by soils that are well suited to crops and vegetation that provide food for some kinds of wetland wildlife.

This soil generally is not suited to building site development and septic tank absorption fields because of ponding and the slow permeability. In this survey area, this soil generally is not used as a site for buildings.

This soil is in capability subclass IVw.

2—Parnell silty clay loam. This is a level, very poorly drained soil in deep depressions on till and lacustrine plains. It is frequently ponded during snowmelt and in periods of heavy rainfall. The areas range from 3 to more than 25 acres in size.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsoil is silty clay about 30 inches thick. It is black in the upper part and very dark gray in the lower part. The underlying material to a depth of 60 inches is olive gray and mottled. It is silty clay in the upper part and silty clay loam in the lower part. In some places, the soil is poorly drained, and a layer of lime accumulation is within a depth of 16 inches.

Included with this soil in mapping are poorly drained Tonka soils in small areas in the shallow part of the depressions. The included soils make up about 10 percent of the map unit.

Permeability is slow. Runoff is ponded. The available water capacity is high. The content of organic matter is high. A seasonal high water table is above or near the surface.

In most areas, this soil is used for pasture and hay or as habitat for wetland wildlife. If the soil is drained, it is suited to small grains, flax, and sunflowers. Few areas, however, are drained because suitable outlets are not available. In the undrained areas, ponded surface water generally prevents tilling and seeding. Soil blowing is a slight hazard and is easily controlled by tillage that leaves crop residue on the surface.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil generally is not suited to trees and shrubs in windbreaks and as environmental plantings. If suitable outlets are available and this soil is adequately drained, climatically adapted species can grow well.

This soil is well suited to use as habitat for wetland wildlife. In most places, the surrounding soils are well suited to crops and vegetation that provide food for some kinds of wetland wildlife.

This soil generally is not suited to building site development and septic tank absorption fields because of ponding and the slow permeability. In this survey area, this soil is not used as a site for buildings.

This soil is in capability subclass Vw.

5—Pits, gravel. This map unit consists of open excavations from which the soil material has been removed to mine the underlying sand and gravel, resulting in irregularly shaped pits and fill sites. The areas range from 3 to more than 30 acres in size. Most areas are barren of vegetation.

Areas of this map unit generally are not suited to cultivated crops, hay, pasture, and trees. Onsite investigation is needed to determine whether an area is suited to building site development, septic tank absorption fields, and other engineering uses.

This map unit is in capability subclass VIIIs.

6—Eramosh peat. This is a level, very poorly drained soil in deep depressions on till plains. It is frequently ponded during snowmelt and in periods of heavy rainfall. In some years, the surface dries out late in the growing season. The areas range from 3 to more than 30 acres in size.

Typically, the organic surface layer is about 8 inches thick. It is very dark brown peat in the upper part and black muck in the lower part. The mineral subsurface layer from 0 to 8 inches is very dark grayish brown silt loam. The underlying material to a depth of 60 inches is silt loam. It is grayish brown in the upper part, very dark grayish brown in the middle part, and gray in the lower part. In some areas, the surface layer is mineral.

Permeability is moderate. Runoff is ponded. The content of organic matter is very high. The available water capacity is high. A seasonal high water table is above or near the surface.

In most areas, this soil is used for pasture and hay or as habitat for wetland wildlife (fig. 7). This soil is best suited to pasture and hay. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil generally is not suited to trees and shrubs in windbreaks and as environmental plantings because of ponding and the lack of adequate outlets.

This soil is well suited to use as habitat for wetland wildlife. In most places, the nearby soils are suited to crops and vegetation that provide food for some kinds of wetland wildlife.

This soil generally is not suited to building site development and septic tank absorption fields because of ponding. In this survey area, this soil is not used as a site for buildings.

This soil is in capability subclass Vw.

10—Svea loam, 0 to 3 percent slopes. This is a level and nearly level, moderately well drained soil in slightly concave areas on till plains. The areas range from 5 to more than 100 acres in size.

Typically, the surface layer is black loam about 11 inches thick. The subsoil is 21 inches thick. It is very dark gray loam in the upper part and mottled, dark brown loam in the lower part. The underlying material to a depth of 60 inches is mottled, olive loam. In some small areas, the soil is somewhat poorly drained, and a layer of lime accumulation is within a depth of 16 inches.

Included with this soil in mapping are small areas of Tonka soils. Tonka soils are poorly drained and are in shallow depressions. They make up about 5 percent of the map unit.

Permeability is moderately slow. Runoff is slow. Soil tilth is good. The content of organic matter and the available water capacity are high. A seasonal high water table is at a depth of 4 to 6 feet.

In most areas, this soil is farmed. It is well suited to small grains, flax, and sunflowers. Soil blowing is a slight hazard and is easily controlled by tillage that leaves crop residue on the surface and by stripcropping.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is well suited to trees and shrubs in windbreaks and as environmental plantings. Climatically adapted species grow well.

This soil is suited to use as building sites and septic tank absorption fields. The shrinking and swelling of the

Figure 7.—An area of Eramosh peat in a depression. Many areas of this soil are used for hay.

soil is a problem for buildings, but this limitation can be overcome by providing foundation drainage, reinforcing basement walls, and providing a positive grade of the soil away from the building. Wetness is a problem for buildings but can be overcome by subsurface drainage. The moderately slow permeability is a limitation for septic tank absorption fields, but it can be overcome by enlarging the field. Wetness is a continuing problem for septic tank absorption fields.

This soil is in capability subclass IIc.

11—Svea-Tonka complex, 0 to 3 percent slopes. This complex consists of level and nearly level soils on till plains in areas that range from 3 to more than 40 acres in size. It is about 70 percent Svea soil and about 30 percent Tonka soil. The Svea soil is moderately well drained, and the Tonka soil is poorly drained. The Tonka soil is in shallow depressions, and the Svea soil is between the depressions. These soils are in areas so intricately mixed or so small that mapping the soils separately was not practical.

Typically, the Svea soil has a surface layer of black loam about 11 inches thick. The subsoil is 21 inches thick. It is very dark gray loam in the upper part and mottled, dark brown loam in the lower part. The underlying material to a depth of 60 inches is mottled, olive loam. In some small areas, the soil is somewhat poorly drained, and a layer of lime accumulation is within a depth of 16 inches.

Typically, the Tonka soil has a surface layer of very dark gray silt loam about 10 inches thick. The subsurface layer is 10 inches thick. It is very dark gray silt loam in the upper part and dark gray silty clay loam in the lower part. The subsoil is very dark grayish brown silty clay about 14 inches thick. The underlying material to a depth of about 60 inches is clay loam. It is dark grayish brown in the upper part and grayish brown in the lower part. The subsurface layer, the subsoil, and the underlying material are mottled.

Permeability is moderately slow in the Svea soil and slow in the Tonka soil. Runoff is slow on the Svea soil and ponded on the Tonka soil. Soil tilth is good. The content of organic matter and the available water capacity are high. A seasonal high water table is above or near the surface of the Tonka soil and at a depth of 4 to 6 feet in the Svea soil.

Most of the acreage is farmed. The soils in this complex are well suited to small grains, flax, and sunflowers. The Tonka soil, however, is poorly suited if it is not drained. The Svea soil can be tilled and planted at the normal time. Surface ponding frequently delays and sometimes prevents tilling and seeding on the Tonka soil. Nevertheless, crops are grown on the Tonka soil in most years. Soil blowing is a slight hazard and is easily controlled by tillage that leaves crop residue on the surface and by stripcropping.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

The Svea soil is well suited to trees and shrubs in windbreaks and as environmental plantings. Climatically adapted species grow well. The Tonka soil, if not drained, generally is not suited to shrubs and trees; however, if it is adequately drained, it is suited to climatically adapted species.

The Tonka soil is well suited to use as habitat for wetland wildlife; the Svea soil is poorly suited. However, the Svea soil is well suited to crops and vegetation that provide food for some kinds of wetland wildlife.

The Svea soil is suited to building site development and septic tank absorption fields. The shrinking and swelling of the soil is a problem for buildings, but this limitation can be overcome by providing foundation drainage, reinforcing basement walls, and providing a positive grade of the soil away from the building. Wetness is a problem for buildings but can be overcome by subsurface drainage. The moderately slow permeability of the Svea soil is a limitation for septic tank absorption fields, but this limitation can be overcome by enlarging the field. Wetness is a continuing limitation for septic tank absorption fields. The Tonka soil generally is not suited to these uses.

The soils in this complex are in capability subclass IIc.

12—Barnes-Svea-Tonka complex, 0 to 3 percent slopes. This complex consists of level and nearly level soils on till plains (fig. 8) in areas that range from 5 to more than 1,000 acres in size. It is about 50 percent Barnes soil, 35 percent Svea soil, and 10 percent Tonka soil. The Barnes soil is well drained, the Svea soil is moderately well drained, and the Tonka soil is poorly drained. The Barnes soil is in plane and slightly convex areas, the Svea soil is in slightly concave areas, and the Tonka soil is in shallow depressions. These soils are in areas so intricately mixed or so small that mapping the soils separately was not practical.

Typically, the Barnes soil has a surface layer of black loam about 7 inches thick. The subsoil is dark brown loam about 10 inches thick. The underlying material to a depth of 60 inches is light olive brown mottled loam. In some places there is more clay in the subsoil than is typical.

Typically, the Svea soil has a surface layer of black loam about 11 inches thick. The subsoil is 21 inches thick. It is very dark gray loam in the upper part and mottled, dark brown loam in the lower part. The underlying material to a depth of 60 inches is mottled, olive loam. In some small areas, the soil is somewhat poorly drained, and a layer of lime accumulation is within a depth of 16 inches.

Typically, the Tonka soil has a surface layer of very dark gray silt loam about 10 inches thick. The subsurface

Figure 8.—An area of Barnes-Svea-Tonka complex, 0 to 3 percent slopes.

layer is 10 inches thick. It is very dark gray silt loam in the upper part and dark gray silty clay loam in the lower part. The subsoil is very dark grayish brown silty clay about 14 inches thick. The underlying material to a depth of 60 inches is clay loam. It is dark grayish brown in the upper part and grayish brown in the lower part. The subsurface layer, the subsoil, and the underlying material are mottled.

Included with these soils in mapping are very poorly drained Parnell soils in small areas in the deepest part of the depressions. The included soils make up about 5 percent of the map unit.

Permeability is moderately slow in the Barnes and Svea soils and slow in the Tonka soil. Runoff is medium on the Barnes soil, slow on the Svea soil, and ponded on the Tonka soil. Soil tilth is good. The content of organic matter and the available water capacity are high. A seasonal high water table is above or near the surface of the Tonka soil and at a depth of 4 to 6 feet in the Svea soil.

Most of the acreage is farmed. The soils in this complex are well suited to small grains, flax, and sunflowers. The Tonka soil, however, is poorly suited if it is not drained. The Barnes and Svea soils can be tilled and planted at the normal time. Surface ponding frequently delays or sometimes prevents tilling and seeding on the Tonka soil. Nevertheless, crops are grown on the Tonka soil in most years. Soil blowing and water erosion are slight hazards and are easily controlled by tillage that leaves crop residue on the surface and by stripcropping. In years of low crop residue, buffer strips, for example, flax strips, help control soil blowing and distribute snow evenly across the field.

A cover of range and pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

The Barnes and Svea soils are well suited to trees and shrubs in windbreaks and as environmental plantings. Many climatically adapted species grow well. The Tonka soil, if not drained, generally is not suited to shrubs and trees; however, if it is adequately drained, it is suited to climatically adapted species.

The Tonka soil is well suited to use as habitat for wetland wildlife. The Barnes and Svea soils are poorly suited. The Barnes and Svea soils, however, are well suited to crops and vegetation that provide food for some wetland wildlife.

The Barnes and Svea soils are suited to use as building sites and septic tank absorption fields. The shrinking and swelling of the soil is a problem at building sites. This problem can be overcome by providing foundation drainage, reinforcing basement walls, and providing a positive grade of the soil away from the building. On the Svea soil, wetness is a problem for buildings. It can be overcome by subsurface drainage. The moderately slow permeability is a limitation for septic tank absorption fields; this limitation can be overcome by enlarging the field. Wetness is a continuing problem for septic tank absorption fields on the Svea soil. The Tonka soil generally is not suited to these uses.

The soils in this complex are in capability subclass IIc.

12B—Barnes-Svea-Tonka complex, 0 to 6 percent slopes. This complex consists of level to undulating soils on till plains in areas that range from 5 to more than 100 acres in size. It is about 50 percent Barnes soil, 35 percent Svea soil, and 10 percent Tonka soil. The Barnes soil is well drained, the Svea soil is moderately well drained, and the Tonka soil is poorly drained. The Barnes soil is in plane and convex areas, the Svea soil is in slightly concave areas, and the Tonka soil is in shallow depressions. These soils are in areas so intricately mixed or so small that mapping the soils separately was not practical.

Typically, the Barnes soil has a surface layer of black loam about 7 inches thick. The subsoil is dark brown loam about 10 inches thick. The underlying material to a depth of 60 inches is light olive brown mottled loam. In some areas, the surface layer is thinner and lighter colored than is typical.

Typically, the Svea soil has a surface layer of black loam about 11 inches thick. The subsoil is 21 inches thick. It is very dark gray loam in the upper part and mottled, dark brown loam in the lower part. The underlying material to a depth of 60 inches is mottled, olive loam. In some areas, the soil is somewhat poorly drained, and a layer of lime accumulation is within a depth of 16 inches.

Typically, the Tonka soil has a surface layer of very dark gray silt loam about 10 inches thick. The subsurface layer is 10 inches thick. It is very dark gray silt loam in the upper part and dark gray silty clay loam in the lower part. The subsoil is very dark grayish brown silty clay about 14 inches thick. The underlying material to a depth of about 60 inches is clay loam. It is dark grayish brown in the upper part and grayish brown in the lower part. The subsurface layer, the subsoil, and the underlying material are mottled.

Included with these soils in mapping are very poorly drained Parnell soils in small areas in the deepest part of depressions. The included soils make up about 5 percent of the map unit.

Permeability is moderately slow in the Barnes and Svea soils and slow in the Tonka soil. Runoff is medium on the Barnes soil, slow on the Svea soil, and ponded on the Tonka soil. Soil tilth is good. The content of organic matter and the available water capacity are high. A seasonal high water table is above or near the surface of the Tonka soil and at a depth of 4 to 6 feet in the Svea soil.

Most of the acreage is farmed. The soils in this complex are well suited to small grains, flax, and sunflowers. The Tonka soil, however, is poorly suited if it is not drained. The Barnes and Svea soils can be tilled and planted at the normal time. Surface ponding frequently delays or sometimes prevents tilling and seeding on the Tonka soil. Nevertheless, crops are grown on the Tonka soil in most years. Soil blowing is a slight hazard, and water erosion is a moderate hazard. Both can be controlled by stripcropping and by tillage that leaves a moderate amount of crop residue on the surface. In years of low crop residue, flax strips or other buffer strips help control soil blowing and distribute snow evenly across the field.

A cover of range and pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

The Barnes and Svea soils are well suited to trees and shrubs in windbreaks and as environmental plantings. Many climatically adapted species grow well. The Tonka soil, if not drained, generally is not suited to shrubs and trees; however, if it is adequately drained, it is suited to climatically adapted species.

The Tonka soil is well suited to use as habitat for wetland wildlife; the Barnes and Svea soils are poorly suited. The Barnes and Svea soils, however, are well suited to crops and vegetation that provide food for some kinds of wetland wildlife.

The Barnes and Svea soils are suited to use as building sites and septic tank absorption fields. The shrinking and swelling of the soil is a problem at building sites. This problem can be overcome by providing foundation drainage, reinforcing basement walls, and providing a positive grade of the soil away from the

building. On the Svea soil, wetness is a problem for buildings. It can be overcome by subsurface drainage. The moderately slow permeability is a limitation for septic tank absorption fields; this limitation can be overcome by enlarging the field. Wetness is a continuing problem for septic tank absorption fields on the Svea soil. The Tonka soil generally is not suited to these uses.

The soils in this complex are in capability subclass IIe.

13—Barnes loam, 0 to 3 percent slopes. This is a level and nearly level, well drained soil on long smooth slopes or on low ridges and knolls on till plains. The areas range from 5 to more than 300 acres in size.

Typically, the surface layer is black loam about 7 inches thick. The subsoil is dark brown loam about 10 inches thick. The underlying material to a depth of 60 inches is light olive brown, mottled loam (fig. 9). In some areas, the surface layer is thicker than is typical. In other areas, the subsoil contains more clay.

Included with this soil in mapping are small areas of poorly drained Tonka soils and somewhat poorly drained Hamerly soils. The Tonka soils are in shallow depressions. The Hamerly soils surround the depressions. The included soils make up about 5 percent of the map unit.

Permeability is moderately slow. Runoff is medium. Soil tilth is good. The content of organic matter and the available water capacity are high.

In most areas, this soil is farmed. It is well suited to small grains, flax, and sunflowers. Soil blowing and water erosion are slight hazards and are easily controlled by tillage that leaves crop residue on the surface and by stripcropping. In years of low crop residue, flax strips or other buffer strips help control soil blowing and distribute snow evenly across the field.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is well suited to trees and shrubs in windbreaks and as environmental plantings. Many climatically adapted species grow well.

This soil is suited to use as building sites and septic tank absorption fields. The shrinking and swelling of the soil is a problem at building sites. This problem can be overcome by providing foundation drainage, reinforcing basement walls, and providing a positive grade of the soil away from the building. The moderately slow permeability is a limitation for septic tank absorption fields, but it can be overcome by enlarging the field.

This soil is in capability subclass IIc.

13B—Barnes loam, 3 to 6 percent slopes. This is an undulating, well drained soil on long smooth slopes or on low ridges and knolls on till plains. The areas range from 5 to more than 100 acres in size.

Typically, the surface layer is black loam about 7

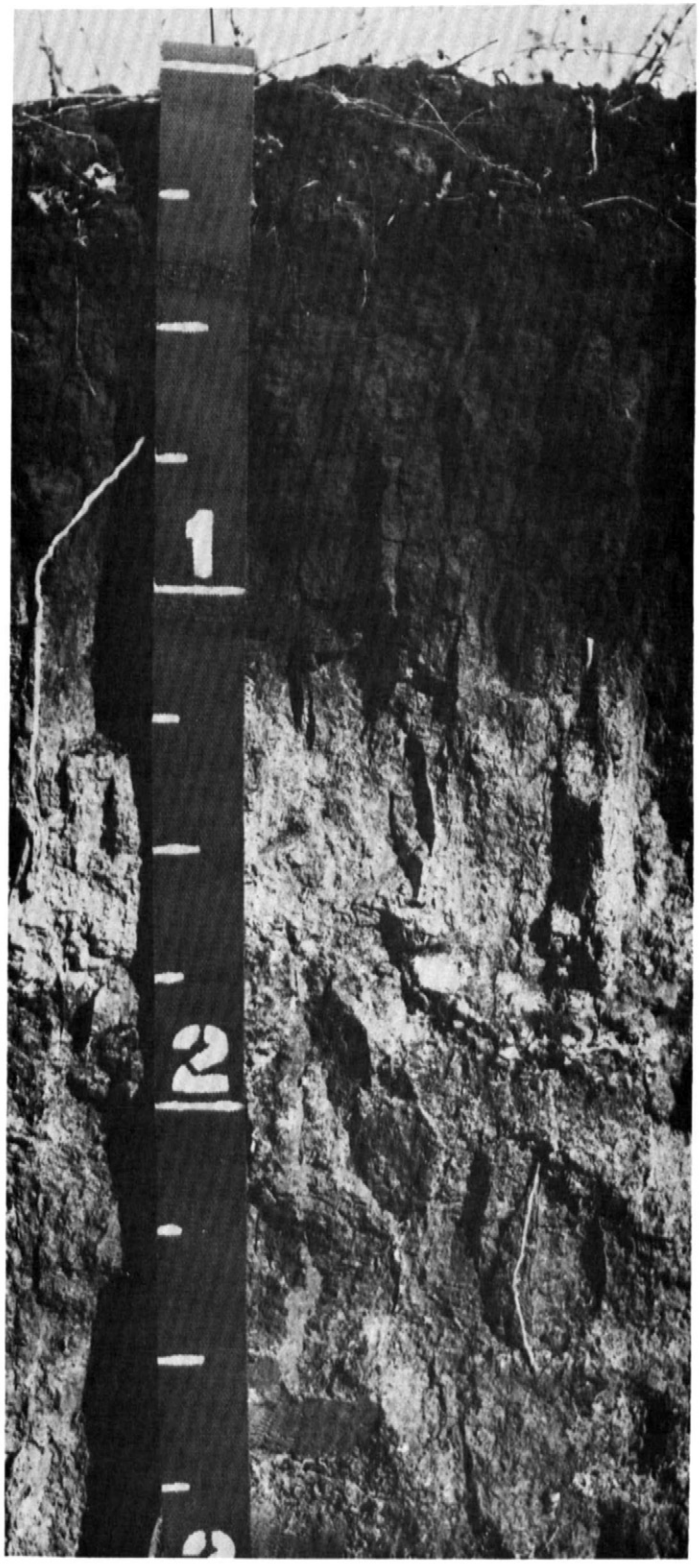


Figure 9.—Profile of Barnes loam showing the dark colored surface layer and subsoil and the light colored underlying material.

inches thick. The subsoil is dark brown loam about 10 inches thick. The underlying material to a depth of 60 inches is light olive brown, mottled loam. In some areas, the surface layer is thicker than 7 inches.

Included with this soil in mapping are small areas of poorly drained Tonka soils and somewhat poorly drained Hamerly soils. The Tonka soils are in shallow depressions. The Hamerly soils surround the depressions. The included soils make up about 5 percent of the map unit.

Permeability is moderately slow. Runoff is medium. Soil tilth is good. The content of organic matter and the available water capacity are high.

In most areas, this soil is farmed. It is well suited to small grains, flax, and sunflowers. Soil blowing is a slight hazard, and water erosion is a moderate hazard. They can be controlled by tillage that leaves moderate amounts of crop residue on the surface and by stripcropping. In years of low crop residue, flax strips or other buffer strips help control soil blowing and distribute snow evenly across the field.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is well suited to trees and shrubs in windbreaks and as environmental plantings. Many climatically adapted species grow well.

This soil is suited to use as building sites and septic tank absorption fields. The shrinking and swelling of the soil is a problem at building sites. This problem can be overcome by providing foundation drainage, reinforcing basement walls, and providing a positive grade of the soil away from the building. The moderately slow permeability is a limitation for septic tank absorption fields, but this limitation can be overcome by enlarging the field.

This soil is in capability subclass IIe.

14C—Barnes-Buse loams, 3 to 9 percent slopes. This complex consists of undulating and gently rolling, well drained soils on till plains in areas that range from 5 to more than 100 acres in size. It is about 60 percent Barnes soils and 40 percent Buse soils. The Barnes soil is on the lower part of side slopes, and the Buse soil is on the upper part of side slopes and on the top of knobs and knolls. These soils are in areas so intricately mixed or so small that mapping the soils separately was not practical.

Typically, the Barnes soil has a surface layer of black loam about 7 inches thick. The subsoil is dark brown loam about 10 inches thick. The underlying material to a depth of 60 inches is mottled, light olive brown loam. In some places, the surface layer is thicker than 7 inches.

Typically, the Buse soil has a surface layer of very dark gray loam about 7 inches thick. The underlying material is dark grayish brown loam in the upper part, brown clay loam in the middle part, and grayish brown clay loam to a depth of 60 inches. In some cultivated areas, the surface layer is very thin and light colored.

Permeability is moderately slow. Runoff is medium. Soil tilth is good. The content of organic matter is high in the Barnes soil and moderate in the Buse soil. The available water capacity is high.

In most areas, these soils are farmed. The soils are suited to small grains and flax. Soil blowing and water erosion are moderate hazards. Erosion can be controlled by tillage that leaves a moderate amount of crop residue on the surface and by stripcropping, flax strips or other buffer strips, and windbreaks.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

These soils are suited to trees and shrubs in windbreaks and as environmental plantings. Many climatically adapted species grow well. Growth is more rapid and the choice of species is wider on the Barnes soil.

These soils are suited to use as building sites and septic tank absorption fields. The shrinking and swelling of the soil is a problem at building sites. This problem can be overcome by providing foundation drainage, reinforcing basement walls, and providing a positive grade of the soil away from the building. The moderately slow permeability is a limitation for septic tank absorption fields, but this limitation can be overcome by enlarging the field.

The soils in this complex are in capability subclass IVe.

15E—Buse-Barnes loams, 9 to 25 percent slopes. This complex consists of rolling and hilly, well drained soils on till plains in areas that range from 5 to more than 50 acres in size. It is about 60 percent Buse soil and 40 percent Barnes soil. The Buse soil is on the upper part of side slopes and on the top of hills and ridges, and the Barnes soil is on the lower part of side slopes. These soils are in areas so intricately mixed that mapping the soils separately was not practical.

Typically, the Buse soil has a surface layer of very dark gray loam about 7 inches thick. The underlying material is dark grayish brown loam in the upper part, brown clay loam in the middle part, and grayish brown clay loam to a depth of 60 inches (fig. 10). In some cultivated areas, the surface layer is very thin and light colored.

Typically, the Barnes soil has a surface layer of black loam about 7 inches thick. The subsoil is dark brown loam about 10 inches thick. The underlying material to a depth of 60 inches is light olive brown, mottled loam. In some areas the surface layer is thicker than 7 inches.

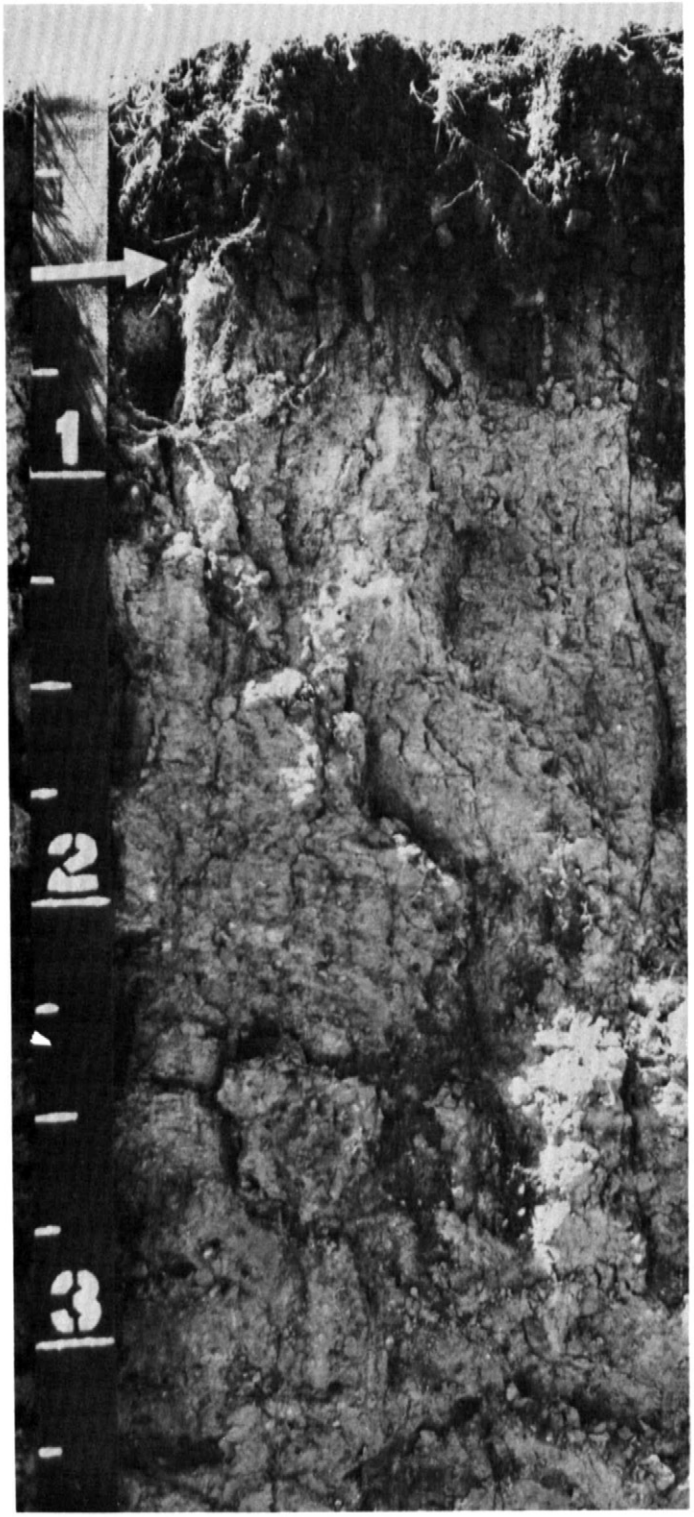


Figure 10.—Profile of Buse loam showing the thin dark colored surface layer and the light colored underlying material. The arrow marks the boundary between the surface layer and the underlying material. Depth is marked in feet.

Permeability is moderately slow. Runoff is rapid. The content of organic matter is moderate in the Buse soil and high in the Barnes soil. The available water capacity is high.

In most areas, these soils are used as native grass pasture. They are best suited to pasture or hay. A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

These soils generally are not suited to trees and shrubs in windbreaks. They are suited to environmental plantings, such as specialized or scalp plantings, but intensive management is needed.

These soils are poorly suited to use as a site for buildings and septic tank absorption fields. Slope is a problem at building sites, but this problem can be overcome by designing buildings to conform to the natural slope of the land. Land shaping may be necessary in some areas. Diversion of surface water away from building sites helps to prevent erosion. The less sloping soils in this complex are suited to use as septic tank absorption fields. The moderately slow permeability is a limitation for septic tank absorption fields, but this limitation can be overcome by enlarging the field. The absorption field needs to be designed to conform to the natural slope of the land.

The soils in this complex are in capability subclass VIe.

17—Hamerly-Tonka complex, 0 to 3 percent slopes. This complex consists of level and nearly level soils on till plains, in areas that range from 5 to more than 200 acres in size. It is about 70 percent Hamerly soil and about 30 percent Tonka soil. The Hamerly soil is somewhat poorly drained and the Tonka soil is poorly drained. The Tonka soil is in shallow depressions, and the Hamerly soil is around and between the depressions. These soils are in areas so intricately mixed or so small that mapping the soils separately was not practical.

Typically, the Hamerly soil has a surface layer of black loam about 7 inches thick. The underlying material is light olive brown and light brownish gray loam in the upper part, mottled, olive loam in the middle part, and mottled, light olive brown clay loam in the lower part, to a depth of 60 inches. In some small areas, the soil is poorly drained. In other areas, the soil is moderately saline.

Typically, the Tonka soil has a surface layer of very dark gray silt loam about 10 inches thick. The subsurface layer is 10 inches thick. It is very dark gray silt loam in the upper part and dark gray silty clay loam in the lower part. The subsoil is very dark grayish brown silty clay about 14 inches thick. The underlying material to a depth of about 60 inches is clay loam. It is dark grayish brown in the upper part and grayish brown in the lower part.

The subsurface layer, the subsoil, and the underlying material are mottled.

Permeability is moderately slow in the Hamerly soil and slow in the Tonka soil. Runoff is slow on the Hamerly soil and ponded on the Tonka soil. Soil tilth is good. The content of organic matter and the available water capacity are high. A seasonal high water table is above or near the surface in the Tonka soil and at a depth of 2 to 4 feet in the Hamerly soil.

In most areas, the soils are farmed, but in some places they are used for pasture and hay. These soils are well suited to small grains, flax, and sunflowers. The Tonka soil, however, is poorly suited if it is not adequately drained. Surface ponding frequently delays or sometimes prevents tillage on the Tonka soil. Nevertheless, crops are grown on the Tonka soil in most years. Soil blowing is a moderate hazard and can be controlled by tillage that leaves a moderate amount of crop residue on the surface and by stripcropping.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

The Hamerly soil is well suited to trees and shrubs in windbreaks and as environmental plantings. Climatically adapted species grow well. The Tonka soil, if not drained, generally is not suited to shrubs and trees; however, if it is adequately drained, it is suited to climatically adapted species.

The Tonka soil is well suited to use as habitat for wetland wildlife; the Hamerly soil is only moderately suited. The Hamerly soil, however, is well suited to crops and vegetation that provide food for some kinds of wetland wildlife.

The Hamerly soil is poorly suited to use as building sites and septic tank absorption fields. The shrinking and swelling of the soil and wetness are problems at building sites. These problems can be overcome by providing foundation drainage, reinforcing basement walls, and providing a positive grade of the soil away from the building. The moderately slow permeability is a limitation for septic tank absorption fields, but it can be overcome by enlarging the field. Wetness is a continuing limitation. Holding tanks are an alternative to onsite disposal. The Tonka soil generally is not suited to these uses.

The soils in this complex are in capability subclass IIe.

19—Hamerly loam, 0 to 3 percent slopes. This is a level and nearly level, somewhat poorly drained soil surrounding depressions and on low flats on till plains. The areas range from 3 to more than 70 acres in size.

Typically, the surface layer is black loam about 7 inches thick. The underlying material is light olive brown and light brownish gray loam in the upper part, mottled, olive loam in the middle part, and mottled, light olive brown clay loam in the lower part to a depth of 60 inches. In some small areas, the soil is moderately saline. Also, in other small areas, the soil is poorly drained.

Included with this soil in mapping are poorly drained Tonka soils in small areas in shallow depressions. The included soils make up about 5 percent of the map unit.

Permeability is moderately slow. Runoff is slow. Soil tilth is good. The content of organic matter and the available water capacity are high. A seasonal high water table is at a depth of 2 to 4 feet.

In most areas, this soil is farmed. It is well suited to small grains, flax, and sunflowers. The seasonal high water table delays tilling and seeding in the spring of some years. Soil blowing is a moderate hazard and can be controlled by tillage that leaves a moderate amount of crop residue on the surface and by stripcropping.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is well suited to trees and shrubs in windbreaks and as environmental plantings. Climatically adapted species grow well.

This soil is poorly suited to use as a site for buildings and septic tank absorption fields. Wetness and the shrinking and swelling of the soil are problems at building sites. These problems can be overcome by providing foundation drainage, reinforcing basement walls, and providing a positive grade of the soil away from the building. The moderately slow permeability is a limitation for septic tank absorption fields, but it can be overcome by enlarging the field. Wetness is a continuing limitation. Holding tanks are an alternative to onsite waste disposal.

This soil is in capability subclass IIe.

20—Hamerly loam, saline, 0 to 3 percent slopes. This is a level and nearly level, somewhat poorly drained, moderately saline soil surrounding depressions and on low flats on till plains. The areas range from 5 to more than 70 acres in size.

Typically, the surface layer is black loam about 7 inches thick. The underlying material is light olive brown and light brownish gray loam in the upper part, mottled, olive loam in the middle part, and mottled, light olive brown clay loam in the lower part to a depth of 60 inches. Salts are present throughout. In some small areas, the soil is nonsaline.

Permeability is moderately slow. Runoff is slow. Soil tilth is good. The content of organic matter is high. The available water capacity is moderate. A seasonal high water table is at a depth of 2 to 4 feet.

In most areas, this soil is farmed. This soil is suited to small grains and flax. The moderate content of salts reduces yields, and the soil is best suited to crops that tolerate salinity, such as barley. The seasonal high water table delays tilling and seeding in the spring of some years. Soil blowing is a moderate hazard. It can be

controlled by tillage that leaves a moderate amount of crop residue on the surface and by stripcropping.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil generally is not suited to trees and shrubs in windbreaks and as environmental plantings because of salinity.

This soil is poorly suited to use as a site for buildings and septic tank absorption fields. The shrinking and swelling of the soil and wetness are problems at building sites. These problems can be overcome by providing foundation drainage, reinforcing basement walls, and providing a positive grade of the soil away from the building. The moderately slow permeability is a limitation for septic tank absorption fields, but it can be overcome by enlarging the field. Wetness is a continuing limitation. Holding tanks are an alternative to onsite disposal.

This soil is in capability subclass IIIs.

21—Vallers loam. This is a level, poorly drained soil on low-lying flats and around depressions on till plains. The areas range from 3 to more than 30 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The underlying material to a depth of 60 inches is mottled, grayish brown loam. In some small areas, the soil is somewhat poorly drained. In other areas, there is a layer of lime accumulation below a depth of 16 inches. Also, in a few areas, the soil is moderately saline.

Permeability is moderately slow. Runoff is slow. Soil tilth is good. The content of organic matter and the available water capacity are high. A seasonal high water table is at a depth of 1 foot to 2.5 feet.

In most areas, the soil is farmed, and in some places, it is used as pasture or for hay. If it is drained, this soil is suited to small grains, flax, and sunflowers. In most years, the seasonal high water table delays tilling and seeding in spring. Drainage is rarely feasible because suitable outlets are not available. Soil blowing is a moderate hazard and can be controlled by tillage that leaves a moderate amount of crop residue on the surface.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil, if drained, is suited to trees and shrubs in windbreaks and as environmental plantings. Climatically adapted species grow well. If this soil is not drained, it generally is not suited to trees and shrubs.

This soil is well suited to use as habitat for wetland wildlife. Most areas are surrounded by soils that are well suited to crops and vegetation that provide food for some kinds of wetland wildlife.

This soil generally is not suited to use as building sites and septic tank absorption fields because of wetness and the moderately slow permeability. This soil generally is not used as a site for buildings.

This soil is in capability subclass IVw.

25—Fargo silty clay. This is a level, poorly drained soil on low-lying lacustrine plains. The areas range from 5 to more than 100 acres in size.

Typically, the surface layer is black silty clay about 5 inches thick. The subsoil is silty clay about 16 inches thick. It is black in the upper part and black and dark grayish brown in the lower part. The underlying material to a depth of 60 inches is dark grayish brown silty clay. In some areas, a layer of lime accumulation is within a depth of 16 inches.

Included with this soil in mapping, in an area northwest of Omemee, are small areas of a well drained soil in a higher position on the landscape.

Permeability is slow. Runoff is very slow. Soil tilth is poor. The content of organic matter and the available water capacity are high. A seasonal high water table ranges from the surface to a depth of 3 feet.

In most areas, this soil is farmed. It is well suited to small grains, flax, and sunflowers. However, the seasonal high water table delays tilling and seeding in spring and occasionally for a longer period. This soil can be tilled only within a narrow range of moisture content because it is very sticky when wet and very hard when dry. Fall tillage and the effects of freezing, thawing, wetting, and drying over winter help to improve tilth and aid seedbed preparation, but fall tillage also increases the hazard of soil blowing. Soil blowing is a moderate hazard and can be controlled by tillage that leaves a moderate amount of crop residue on the surface and by stripcropping.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is well suited to trees and shrubs in windbreaks and as environmental plantings. Climatically adapted species grow well.

This soil generally is not suited to use as building sites and septic tank absorption fields because of wetness, shrinking and swelling, and the slow permeability. This soil generally is not used as a site for buildings.

This soil is in capability subclass IIw.

26—Fargo and Hegne silty clays, wet. This map unit consists of level, poorly drained soils in depressions on lacustrine plains. The soils are frequently ponded except in some dry years. The areas range from 5 to more than 60 acres in size. An individual area may be all Fargo silty clay or all Hegne silty clay or any combination of the two

soils. The soils are mapped together because the management of both is similar.

Typically, the surface layer of the Fargo soil is black silty clay about 5 inches thick. The subsoil is silty clay about 16 inches thick. It is black in the upper part and black and dark grayish brown in the lower part. The underlying material to a depth of 60 inches is dark grayish brown silty clay.

Typically, the surface layer of the Hegne soil is very dark gray silty clay about 7 inches thick. The underlying material to a depth of 60 inches is silty clay. It is dark gray in the upper part and olive gray in the lower part.

Permeability is slow in the Fargo soil and very slow in the Hegne soil. Runoff is ponded. The content of organic matter is high. The available water capacity is high. A seasonal high water table is above or near the surface.

In most areas, the soils are used for pasture or hay or as habitat for wetland wildlife. These soils generally are not suited to cultivated crops. In most areas, the soils are not drained because suitable outlets are not available. In some areas, the soils are cropped during extended dry periods; however, heavy rains can cause ponding that damages or destroys the crop. If these soils are cultivated, soil blowing is a moderate hazard but can be controlled by tillage that leaves a moderate amount of crop residue on the surface and by stripcropping.

A cover of range or pasture plants or of hay is effective in controlling erosion. During long wet periods, rushes and cattails commonly are dominant, and these plants are poorly suited to pasture and hay. Seeding reed canarygrass or Garrison creeping foxtail greatly improves the pasture or hay crops on these soils. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition and maintain the desirable plant species.

The soils are not suited to trees and shrubs in windbreaks and as environmental plantings. The soils are too wet for most climatically adapted species to survive. If suitable outlets are available and the soils are drained, climatically adapted species grow well.

These soils are well suited to use as habitat for wetland wildlife. Most areas are surrounded by soils that are well suited to crops and vegetation that provide food for some kinds of wetland wildlife.

These soils generally are not suited to use as building sites and septic tank absorption fields because of ponding, the shrinking and swelling of the soil, and the slow or very slow permeability. These soils generally are not used as sites for buildings.

These soils are in capability subclass Vw.

27—Hegne silty clay. This is a level, poorly drained soil on low-lying lacustrine plains. The areas range from 5 to more than 50 acres in size.

Typically, the surface layer is very dark gray silty clay about 7 inches thick. The underlying material to a depth of 60 inches is silty clay that is dark gray in the upper part and olive gray in the lower part. In some areas, a layer of lime accumulation is below a depth of 16 inches.

Permeability is very slow. Runoff is slow. Soil tilth is poor. The content of organic matter and the available water capacity are high. A seasonal high water table is at a depth of 1 foot to 2.5 feet.

In most areas, this soil is farmed. It is well suited to small grains, flax, and sunflowers; however, the seasonal high water table delays tilling and seeding in spring and occasionally for a longer period. This soil can be tilled only within a narrow range of moisture content because it is very sticky when wet and very hard when dry. Fall tillage and the effects of freezing, thawing, wetting, and drying over winter improve tilth and aid seedbed preparation. Fall tillage, however, increases the hazard of soil blowing. Soil blowing is a moderate hazard and can be controlled by stripcropping and by tillage that leaves a moderate amount of crop residue on the surface.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is well suited to trees and shrubs in windbreaks and as environmental plantings. Climatically adapted species grow well.

This soil generally is not suited to use as building sites and septic tank absorption fields because of wetness, shrinking and swelling, and the slow permeability. This soil generally is not used as a site for buildings.

This soil is in capability subclass IIw.

28—Hegne silty clay, saline. This is a level, poorly drained, moderately saline soil on low-lying lacustrine plains. It is occasionally ponded after snowmelt and during periods of heavy rainfall. The areas range from 10 to more than 50 acres in size.

Typically, the surface layer is very dark gray silty clay about 7 inches thick. The underlying material to a depth of 60 inches is silty clay. It is dark gray in the upper part and olive gray in the lower part. Salts are present throughout. In some areas, there is a layer of lime accumulation below a depth of 16 inches. In other areas, the soil is nonsaline.

Permeability is very slow. Runoff is slow. Soil tilth is poor. The content of organic matter is high. The available water capacity is moderate. A seasonal high water table is at a depth of 1 foot to 2.5 feet.

In most areas, this soil is farmed. It is suited to small grains and flax. The moderate salt content reduces yields, and this soil is best suited to crops that are tolerant of salinity, such as barley. The seasonal high water table delays tilling and seeding in spring and occasionally for a longer period. This soil can be tilled only within a narrow range of moisture content because

it is very sticky when wet and very hard when dry. Fall tillage and the effects of freezing, thawing, wetting, and drying over winter improve tilth and aid seedbed preparation. Fall tillage, however, increases the hazard of soil blowing. Soil blowing is a moderate hazard and can be controlled by stripcropping and by tillage that leaves a moderate amount of crop residue on the surface.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil generally is not suited to trees and shrubs in windbreaks and as environmental plantings because of salinity and wetness.

This soil generally is not suited to use as building sites and septic tank absorption fields because of ponding, shrinking and swelling, and the slow permeability. This soil generally is not used as a site for buildings.

This soil is in capability subclass IIIs.

30—Overly silty clay loam. This is a level, moderately well drained soil on lacustrine plains. The areas range from 20 to more than 200 acres in size.

Typically, the surface layer is black silty clay loam about 7 inches thick. The subsurface layer is very dark gray silty clay loam about 10 inches thick. The subsoil is dark brown silty clay loam about 13 inches thick. The underlying material is light olive brown silty clay loam in the upper part, mottled, olive brown silty clay loam in the middle part, and mottled, olive brown silty clay in the lower part to a depth of 60 inches.

Permeability is moderately slow. Runoff is slow. Soil tilth is fair. The content of organic matter and the available water capacity are high.

In most areas, this soil is farmed. It is well suited to small grains, flax, and sunflowers. Timely cultivation helps to maintain or improve soil tilth. Tillage should be avoided when the soil is too wet or too dry. Soil blowing is a slight hazard and is easily controlled by stripcropping and by tillage that leaves crop residue on the surface.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is well suited to trees and shrubs in windbreaks and as environmental plantings. Climatically adapted species grow well.

This soil is suited to use as building sites and septic tank absorption fields. The moderately slow permeability is a limitation for septic tank absorption fields, but this limitation can be overcome by enlarging the field. The shrinking and swelling is a problem at building sites, but this problem can be overcome by providing foundation drainage, reinforcing basement walls, and providing a positive grade of the soil away from the building.

This soil is in capability subclass IIc.

31—Bearden silty clay loam. This is a level, somewhat poorly drained soil on low-lying flats on lacustrine plains. The areas range from 10 to more than 100 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 8 inches thick. The mottled underlying material is grayish brown silty clay loam in the upper part, olive brown silty clay loam in the middle part, and olive gray clay loam in the lower part to a depth of 60 inches. In some areas, the soil is poorly drained.

Permeability is moderately slow. Runoff is slow. Soil tilth is fair. Organic matter content and available water capacity are high. A seasonal high water table is at a depth of 1.5 to 2.5 feet.

In most areas, this soil is farmed. It is well suited to small grains, flax, and sunflowers. The seasonal high water table delays tilling and seeding in the spring. Timely cultivation helps to maintain or improve soil tilth. Tillage should be avoided when the soil is too wet or too dry. Soil blowing is a moderate hazard and can be controlled by stripcropping and by tillage that leaves a moderate amount of crop residue on the surface.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is well suited to trees and shrubs in windbreaks and as environmental plantings. Climatically adapted species grow well.

This soil is poorly suited to use as building sites and septic tank absorption fields. Wetness and the shrinking and swelling are problems at building sites. These problems can be overcome by providing foundation drainage, reinforcing basement walls, and providing a positive grade of the soil surface away from the building. The moderately slow permeability is a limitation for septic tank absorption fields, but this limitation can be overcome by enlarging the field. Wetness is a continuing limitation. Holding tanks are an alternative to onsite disposal.

This soil is in capability subclass IIe.

33—Colvin silty clay loam. This is a level, poorly drained soil on low-lying flats and in shallow depressions on glacial lacustrine plains. The areas range from 5 to more than 50 acres in size.

Typically, the surface layer is black silty clay loam about 8 inches thick. The underlying material is silty clay loam. It is dark gray in the upper part, gray in the middle part, and mottled, grayish brown to a depth of 60 inches.

Permeability is moderately slow. Runoff is very slow. Soil tilth is fair. The content of organic matter and the available water capacity are high. A seasonal high water table is at or near the surface.

In most areas, this soil is in native grasses and is used as pasture or hayland. If it is drained, the soil is suited to small grains, flax, and sunflowers. In most places, it is not drained because suitable outlets are not available. In undrained areas, wetness frequently delays or prevents tilling and seeding. Soil blowing is a moderate hazard and can be controlled by stripcropping and by tillage that leaves a moderate amount of crop residue on the surface.

A cover of range or pasture plants or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is suited to trees and shrubs in windbreaks and as environmental plantings. If outlets are available and the soil is adequately drained, climatically adapted species grow well.

This soil is well suited to use as habitat for wetland wildlife. Most areas are surrounded by soils that are well suited to crops and vegetation that provide food for some kinds of wetland wildlife.

This soil generally is not suited to use as building sites and septic tank absorption fields because of wetness and the moderately slow permeability. This soil generally is not used as a site for buildings.

This soil is in capability subclass IVw.

34—Colvin silty clay loam, saline. This is a level, poorly drained, moderately saline soil on low-lying flats and in shallow depressions on glacial lacustrine plains and on bottom lands adjacent to intermittent drainage channels. In lower lying areas, this soil is subject to frequent ponding. The areas range from 10 to more than 200 acres in size.

Typically, the surface layer is black silty clay loam about 8 inches thick. The underlying material is silty clay loam. It is dark gray in the upper part, gray in the middle part, and mottled, grayish brown in the lower part to a depth of 60 inches. In some areas, the soil is very poorly drained.

Permeability is moderately slow. Runoff is ponded. The content of organic matter is high. The available water capacity is moderate. A seasonal high water table is above or near the surface.

In most places, this soil is in native grasses and is used for pasture or hay. This soil is not suited to small grains, flax, and sunflowers. Tilling and seeding commonly are prevented by the seasonal high water table and occasional ponding.

A cover of native plants is effective in controlling erosion. Timely deferment of grazing and restricted use during wet periods help keep the pasture and soil in good condition. The most suitable season for grazing is late in summer or early in fall.

This soil generally is not suited to trees and shrubs in windbreaks and as environmental plantings because of ponding, the lack of drainage outlets, and salinity.

This soil is well suited to use as habitat for wetland wildlife. Most areas are surrounded by soils that are well suited to crops and vegetation that provide food for some kinds of wetland wildlife.

This soil generally is not suited to use as building sites and septic tank absorption fields because of wetness, ponding, and the moderately slow permeability. This soil generally is not used as sites for buildings.

This soil is in capability subclass Vw.

36—Overly-Great Bend silty clay loams, 0 to 3 percent slopes. This complex consists of level and nearly level soils on lacustrine plains. Overly soils make up about 60 percent of the complex and Great Bend soils make up about 40 percent. Overly soils are moderately well drained and are on plane or slightly concave slopes; Great Bend soils are well drained and are in slightly convex areas. The areas of the two soils are so intricately mixed that mapping the soils separately was not practical. The mapped areas range from 10 to more than 75 acres in size.

Typically, the Overly soil has a surface layer of black silty clay loam about 7 inches thick. The subsurface layer is very dark gray silty clay loam about 10 inches thick. The subsoil is dark brown silty clay loam about 13 inches thick. The underlying material is light olive brown silty clay loam in the upper part, mottled, olive brown silty clay loam in the middle part, and mottled, olive brown silty clay to a depth of 60 inches.

Typically, the Great Bend soil has a surface layer of very dark gray silty clay loam about 6 inches thick. The subsoil is very dark grayish brown silty clay loam about 8 inches thick. The underlying material to a depth of 60 inches is silty clay loam. It is light yellowish brown in the upper part and light olive brown in the lower part.

Permeability is moderately slow. Runoff is slow on the Overly soil and medium on the Great Bend soil. Soil tilth is fair. The content of organic matter and the available water capacity are high.

In most areas, these soils are farmed. They are well suited to small grains, flax, and sunflowers. Soil tilth can be maintained or improved by timely cultivation. Cultivation should be avoided when the soil is too wet or too dry. Soil blowing is a slight hazard and is easily controlled by tillage that leaves crop residue on the surface and by stripcropping. In years of low crop residue, flax strips or other buffer strips are helpful in controlling soil blowing and in distributing snow evenly across the field.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

These soils are well suited to trees and shrubs in windbreaks and environmental plantings. Climatically adapted species grow well on both soils, but the growth

rate is more rapid and the choice of trees to plant is wider on the Overly soil.

These soils are well suited to use as building sites and suited to use as septic tank absorption fields. The moderately slow permeability is a limitation for septic tank absorption fields, but this limitation can be overcome by enlarging the field. The shrinking and swelling of the Overly soil is a problem at building sites. This problem can be overcome by providing foundation drainage, reinforcing basement walls, and providing a positive grade of the soil away from the building.

These soils are in capability subclass IIc.

40—Gardena silt loam, 0 to 3 percent slopes. This is a level and nearly level, moderately well drained soil on lacustrine plains. The areas range from 30 to more than 600 acres in size.

Typically, the surface layer is black silt loam about 9 inches thick. The subsoil is silt loam about 15 inches thick. It is black in the upper part and very dark grayish brown in the lower part. The underlying material is grayish brown and light brownish gray silt loam in the upper part, grayish brown silt loam in the middle part, and dark grayish brown, grayish brown, and light brownish gray silty clay loam to a depth of 60 inches. In some areas, the surface layer is thinner, and in other areas, there is a layer of lime accumulation within a depth of 16 inches.

Included with this soil in mapping are small areas of Tonka soils, which are poorly drained and are in shallow depressions. They make up about 5 percent of the map unit.

Permeability is moderate. Runoff is slow. Soil tilth is good. The content of organic matter and the available water capacity are high. A seasonal high water table is at a depth of 4 to 6 feet.

In most areas, this soil is farmed. It is well suited to small grains, flax, and sunflowers. Soil blowing is a slight hazard and can be controlled by stripcropping and by tillage that leaves crop residue on the surface.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is well suited to trees and shrubs in windbreaks and as environmental plantings. Climatically adapted species grow well.

This soil is suited to use as a site for buildings and as septic tank absorption fields. Wetness is a problem at building sites, but this problem can be overcome by foundation drainage. Wetness is a continuing problem for septic tank absorption fields.

This soil is in capability subclass IIe.

42B—Eckman silt loam, 3 to 6 percent slopes. This is an undulating, well drained soil on lacustrine plains. The areas range from 10 to more than 50 acres in size.

Typically, the surface layer is black silt loam about 6 inches thick. The subsoil is silt loam about 8 inches thick. It is very dark grayish brown in the upper part and dark grayish brown in the lower part. The underlying material to a depth of 60 inches is light olive brown silt loam. It is mottled below a depth of 28 inches. In some areas, the soil is moderately well drained. Also, in other areas, slopes range from 6 to 9 percent.

Permeability is moderate. Runoff is medium. Soil tilth is good. The content of organic matter and the available water capacity are high.

In most areas, this soil is farmed. It is well suited to small grains, flax, and sunflowers. Soil blowing is a slight hazard and can be controlled by stripcropping and by tillage that leaves crop residue on the surface.

A cover of pasture or range plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is well suited to trees and shrubs in windbreaks and as environmental plantings. Many climatically adapted species grow well.

This soil is well suited to use as building sites and septic tank absorption fields.

This soil is in capability subclass IIe.

45—Glyndon silt loam. This is a level, somewhat poorly drained soil on low flats and around depressions on lacustrine plains. The areas range from 5 to more than 600 acres in size.

Typically, the surface layer is very dark gray silt loam about 8 inches thick. The underlying material is grayish brown silt loam in the upper part, light olive brown very fine sandy loam in the middle part, and mottled, light olive brown silt loam to a depth of 60 inches.

Included with this soil in mapping are poorly drained Tonka soils in small areas in shallow depressions. The included soils make up about 5 percent of the map unit.

Permeability is moderate. Runoff is slow. Soil tilth is good. The content of organic matter and the available water capacity are high. A seasonal high water table is at a depth of 2.5 to 6 feet.

In most areas, this soil is farmed. It is well suited to small grains, flax, and sunflowers. The seasonal high water table delays tilling and seeding in the spring. Soil blowing is a moderate hazard and can be controlled by stripcropping and by tillage that leaves a moderate amount of crop residue on the surface.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is well suited to trees and shrubs in windbreaks and as environmental plantings. Climatically adapted species grow well.

This soil is suited to use as building sites and poorly suited to use as septic tank absorption fields. Caving or

sloughing of the walls of shallow excavations, as for basements, can be prevented by shoring trench walls. Wetness is a problem at building sites, but this problem can be overcome by foundation drainage. Wetness is a continuing limitation for septic tank absorption fields. Holding tanks are an alternative to onsite disposal.

This soil is in capability subclass IIe.

46—Glyndon and Bearden soils, saline. This map unit consists of level, somewhat poorly drained, moderately saline soils on broad flats and swales on glacial lacustrine plains. The areas generally range from 5 to more than 50 acres in size. An individual area may be all Glyndon silt loam, saline, or all Bearden silty clay loam, saline, or any combination of the two soils. These soils were mapped together because the management needed for both soils is similar.

Typically, the surface layer of the Glyndon soil is very dark gray silt loam about 8 inches thick. The underlying material is grayish brown silt loam in the upper part, light olive brown very fine sandy loam in the middle part, and mottled, light olive brown silt loam to a depth of 60 inches. Salts are present throughout. In some areas, the soil is nonsaline.

Typically, the surface layer of the Bearden soil is very dark gray silty clay loam about 8 inches thick. The mottled underlying material is grayish brown silty clay loam in the upper part, olive brown silty clay loam in the middle part, and olive gray clay loam to a depth of 60 inches. Salts are present throughout. In some areas, the soil is nonsaline.

Permeability is moderate in the Glyndon soil and moderately slow in the Bearden soil. Runoff is slow. Soil tilth is good on the Glyndon soil and fair on the Bearden soil. The content of organic matter is high. The available water capacity is moderate. A seasonal high water table is at a depth of 2.5 to 6 feet in the Glyndon soil and 3 to 5 feet in the Bearden soil.

In most areas, these soils are farmed. They are suited to small grains and flax. The moderate salt content reduces yields, and these soils are best suited to crops that tolerate salinity such as barley. Timely tillage can maintain or improve soil tilth. Wetness delays tilling and seeding in spring of some years. Soil blowing is a moderate hazard but can be controlled by stripcropping and by tillage that leaves a moderate amount of crop residue on the surface.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

These soils generally are not suited to trees and shrubs in windbreaks and as environmental plantings because of salinity.

These soils are poorly suited to use as building sites and septic tank absorption fields. Wetness is a problem at building sites. This problem can be overcome by foundation drainage. On the Glyndon soil, caving or sloughing of the walls of shallow excavations, as for basements, can be prevented by shoring trench walls. The moderately slow permeability is a limitation for septic tank absorption fields, but this limitation can be overcome by enlarging the field. Wetness is a continuing limitation. Holding tanks are an alternative to onsite disposal.

These soils are in capability subclass IIIs.

50—Embden fine sandy loam, 0 to 3 percent slopes. This is a level and nearly level, moderately well drained soil on outwash plains. The areas range from 5 to more than 300 acres in size.

Typically, the surface layer is very dark gray fine sandy loam about 8 inches thick. The subsurface layer is very dark gray fine sandy loam about 6 inches thick. The subsoil is fine sandy loam about 14 inches thick. It is very dark brown in the upper part and very dark grayish brown in the lower part. The underlying material is grayish brown fine sandy loam to a depth of 60 inches. It is mottled below a depth of 48 inches. In some areas, the dark color of the surface layer extends to a depth of more than 16 inches. In other areas, the underlying material is loam.

Permeability is moderately rapid. Runoff is slow. Soil tilth is good. The content of organic matter is high. The available water capacity is moderate. A seasonal high water table is at a depth of 4 to 6 feet.

In most areas, this soil is farmed. It is well suited to small grains, flax, and sunflowers. This soil is slightly droughty because the available water capacity is moderate. Water erosion is a slight hazard, and soil blowing is a severe hazard. Tillage that leaves a maximum amount of crop residue on the surface, flax strips or other buffer strips, stripcropping, and windbreaks help to reduce soil blowing. This soil is particularly well suited to rye because rye is a fall-seeded crop that protects the soil from blowing and makes the best use of the available moisture.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing keep the pasture and soil in good condition.

This soil is well suited to trees and shrubs in windbreaks and as environmental plantings. Climatically adapted species grow well.

This soil is suited to use as building sites and septic tank absorption fields. Caving or sloughing of the walls of shallow excavations, as for basements, can be prevented by shoring trench walls. Wetness is a limitation at building sites. This problem can be overcome by foundation drainage. Wetness is a continuing limitation for septic tank absorption fields.

This soil is in capability subclass IIIe.

51B—Egeland fine sandy loam, 3 to 6 percent slopes. This is an undulating, well drained soil on glacial outwash plains. The areas range from 5 to about 100 acres in size.

Typically, the surface layer is black fine sandy loam about 6 inches thick. The subsoil is fine sandy loam about 26 inches thick. It is very dark grayish brown in the upper part, dark grayish brown in the middle part, and dark brown in the lower part. The underlying material is grayish brown fine sandy loam in the upper part and grayish brown, stratified fine sandy loam and loam in the lower part to a depth of 60 inches. In some areas, the surface layer is more than 6 inches thick. In other areas, slopes range from 6 to 9 percent.

Permeability is moderately rapid. Runoff is medium. Soil tilth is good. The content of organic matter and the available water capacity are moderate.

In most areas, this soil is farmed. It is suited to small grains, flax, and sunflowers. This soil is slightly droughty because the available water capacity is moderate. Soil blowing is a severe hazard, and water erosion is a slight hazard. Tillage that leaves a maximum amount of crop residue on the surface, flax strips or other buffer strips, stripcropping, and windbreaks help to reduce soil blowing. This soil is particularly well suited to rye because rye is a fall-seeded crop that protects the soil from blowing and makes the best use of the available moisture.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is suited to trees and shrubs in windbreaks and as environmental plantings. Most climatically adapted species grow well.

This soil is well suited to use as building sites and septic tank absorption fields. Caving or sloughing of the walls of shallow excavations, as for basements, can be prevented by shoring trench walls.

This soil is in capability subclass IIIe.

53—Wyndmere fine sandy loam. This is a level, somewhat poorly drained soil on low flats and swales on outwash plains. The areas range from 5 to more than 150 acres in size.

Typically, the surface layer is black fine sandy loam about 7 inches thick. The next layer is fine sandy loam 12 inches thick. It is dark gray in the upper part and grayish brown in the lower part. The underlying material to a depth of 60 inches is light olive brown. It is fine sandy loam in the upper part and mottled loamy fine sand in the lower part (fig. 11). In some areas, the surface layer is thicker than is typical.

Permeability is moderately rapid. Runoff is slow. Soil tilth is good. The content of organic matter is high. The available water capacity is moderate. A seasonal high water table is at a depth of 2 to 5 feet.

In most areas, this soil is farmed. It is well suited to small grains, flax, and sunflowers. Soil blowing is a severe hazard. Tillage that leaves a maximum amount of crop residue on the surface, flax strips or other buffer strips, stripcropping, and windbreaks help to reduce erosion. Wetness delays tilling and seeding in spring in some years. This soil is particularly well suited to rye because rye is a fall-seeded crop that protects the soil from blowing.

A cover of range and pasture plants or of hay is effective in controlling erosion. Proper stocking rates,

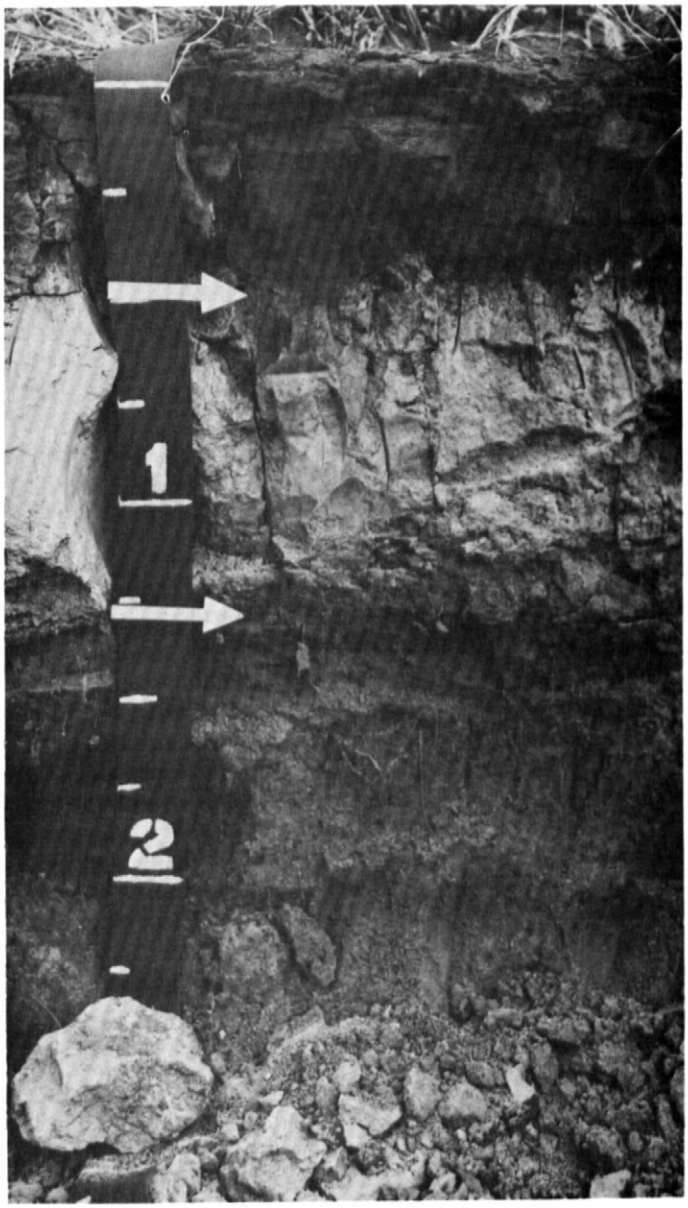


Figure 11.—Profile of Wyndmere fine sandy loam. Arrows mark the top and bottom of the calcium-enriched layer. Depth is marked in feet.

pasture rotation, and timely deferment of grazing help maintain the pasture and soil in good condition.

This soil is well suited to trees and shrubs in windbreaks and as environmental plantings. Climatically adapted species grow well.

This soil is poorly suited to use as building sites and septic tank absorption fields. Caving or sloughing of the walls of shallow excavations, as for basements, can be prevented by shoring trench walls. Wetness is a problem for buildings. It can be overcome by foundation drainage. Wetness is a continuing limitation for septic tank absorption fields. Holding tanks are an alternative to onsite disposal.

This soil is in capability subclass IIIe.

54—Ulen loamy fine sand, 0 to 3 percent slopes. This is a level and nearly level, somewhat poorly drained soil on low flats and in shallow depressions on lacustrine and outwash plains. The areas range from 10 to more than 250 acres in size.

Typically, the surface layer is black loamy fine sand about 9 inches thick. The subsurface layer, which is 4 inches thick, is very dark gray loamy fine sand. The layer below that, which also is 4 inches thick, is dark gray loamy fine sand. The mottled underlying material is dark brown loamy fine sand in the upper part, yellowish brown fine sand in the middle part, and light olive brown fine sand to a depth of 60 inches. In some areas, the soil is poorly drained. In other areas, the soil is moderately well drained, and there is a layer of lime accumulation below a depth of 16 inches. Also, in a few areas, the soil is slightly to moderately saline.

Permeability is rapid. Runoff is slow. Soil tilth is fair. The content of organic matter is moderate. The available water capacity is low. A seasonal high water table is at a depth of 2.5 to 6 feet.

In most areas, this soil is farmed, but in some places, it is used for hay or pasture. This soil is suited to small grains and flax, but it is poorly suited to sunflowers. Wetness delays tilling and seeding in spring of some years. Soil blowing is a severe hazard. Tillage that leaves a maximum amount of crop residue, flax strips or other buffer strips, stripcropping, and windbreaks help to reduce soil blowing. The low available water capacity makes this soil droughty. This soil is particularly well suited to rye because rye is a fall-seeded crop that protects the soil from blowing and makes the best use of the available moisture.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition. If the pasture is overgrazed, soil blowing is a hazard.

This soil is suited to trees and shrubs in windbreaks and as environmental plantings. Most climatically adapted species grow well.

This soil is suited to use as building sites and poorly suited to use as septic tank absorption fields. Wetness is a problem for buildings. It can be overcome by foundation drainage. The caving or sloughing of the walls of shallow excavations, as for basements, can be prevented by shoring trench walls. Because of the poor filtering characteristics of the soil, effluent from septic tank absorption fields can pollute the ground water. Wetness is a continuing limitation for absorption fields. Holding tanks are an alternative to onsite disposal.

This soil is in capability subclass IVe.

55—Hecla loamy fine sand, 0 to 3 percent slopes. This is a level and nearly level, moderately well drained soil on lacustrine and glacial outwash plains. The areas range from 10 to more than 300 acres in size.

Typically, the surface layer is black loamy fine sand about 14 inches thick. The subsurface layer is very dark gray loamy fine sand about 7 inches thick. The underlying material is very dark grayish brown loamy fine sand in the upper part and dark grayish brown fine sand in the lower part, to a depth of 60 inches. It is mottled from a depth of 39 to 48 inches. In some areas, the soil is well drained.

Permeability is rapid. Runoff is slow. Soil tilth is fair. The content of organic matter is moderate. The available water capacity is low. A seasonal high water table is at a depth of 3 to 6 feet.

In most areas, this soil is farmed, but in a few places it is used as pasture or for hay. This soil is poorly suited to small grains, flax, and sunflowers. It is droughty because the available water capacity is low. Soil blowing is a severe hazard, and water erosion is a slight hazard. Tillage that leaves a maximum amount of crop residue on the surface, buffer strips, stripcropping, and windbreaks help to reduce soil blowing (fig. 12). This soil is particularly well suited to rye because rye is a fall-seeded crop that protects the soil from blowing and makes the best use of the available moisture.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition. If this soil is overgrazed, soil blowing is a hazard. Grazing needs to be controlled to maintain a good vegetative cover.

This soil is well suited to trees and shrubs in windbreaks and as environmental plantings. All climatically adapted species grow well.

This soil is suited to use as a site for buildings and poorly suited to septic tank absorption fields. Wetness is a problem for buildings; it can be overcome by foundation drainage. Caving or sloughing of walls is a problem in shallow excavations, as for basements, but it can be prevented by shoring trench walls. Because of the rapid permeability and the poor filtering characteristics of the soil, effluent from septic tanks can

Figure 12.—Windbreaks and crop residue management help to reduce soil blowing on Hecla loamy fine sand, 0 to 3 percent slopes.

pollute the ground water. Wetness is a continuing limitation for absorption fields. Holding tanks are an alternative to onsite disposal.

This soil is in capability subclass IVe.

56B—Maddock loamy fine sand, 3 to 6 percent slopes. This is an undulating, well drained soil on lacustrine and glacial outwash plains. The areas range from 20 to more than 300 acres in size.

Typically, the surface layer is black loamy fine sand about 6 inches thick. The subsurface layer is very dark gray loamy fine sand about 8 inches thick. The subsoil is dark grayish brown loamy fine sand about 16 inches thick. The underlying material is loamy fine sand that is olive brown in the upper part and grayish brown in the lower part, to a depth of 60 inches. In some areas, the soil is moderately well drained.

Permeability is rapid. Runoff is slow. Soil tilth is fair. The content of organic matter is moderate. The available water capacity is low.

In many areas, this soil is farmed, but in a few places it is used for hay or as pasture. This soil is poorly suited to small grains, flax, and sunflowers. It is droughty because the available water capacity is low. Soil blowing is a severe hazard, and water erosion is a slight hazard. Tillage that leaves a maximum amount of crop residue on the surface, buffer strips, stripcropping, and windbreaks help to reduce soil blowing. This soil is particularly well suited to rye because rye is a fall-seeded crop that protects the soil from blowing and makes the best use of the available moisture.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help

keep the pasture and soil in good condition. If this soil is overgrazed, soil blowing is a hazard. Grazing needs to be controlled to maintain a good plant cover.

This soil is suited to trees and shrubs in windbreaks and as environmental plantings. Some climatically adapted species grow well.

This soil is well suited to use as building sites and poorly suited to septic tank absorption fields. Caving or sloughing of walls is a problem in shallow excavations, as for basements, but it can be prevented by shoring trench walls. Because of the rapid permeability and the poor filtering characteristics of the soil, effluent from septic tanks can pollute the ground water. Holding tanks are an alternative to onsite disposal.

This soil is in capability subclass IVe.

61B—Hecla loamy fine sand, 1 to 6 percent slopes. This is a nearly level and undulating, moderately well drained soil on sandy outwash plains. The land surface is hummocky. Small knolls and depressions are characteristic of the areas, which range from 10 to more than 150 acres in size.

Typically, the surface layer is black loamy fine sand about 14 inches thick. The subsurface layer is very dark gray loamy fine sand about 7 inches thick. The underlying material is very dark grayish brown loamy fine sand in the upper part and dark grayish brown fine sand in the lower part, to a depth of 60 inches. It is mottled from a depth of 39 to 48 inches. In some places, the soil is excessively drained.

Included with this soil in mapping are small areas of Arveson soils, which are poorly drained and are in low basins and swales. They make up about 10 percent of the map unit.

Permeability is rapid. Runoff is slow. The content of organic matter is moderate. The available water capacity is low. A seasonal high water table is at a depth of 3 to 6 feet.

In most areas, this soil is used as native grass pasture. It is best suited to native grass pasture or hay. A cover of pasture, hay, or range plants is effective in controlling erosion. Proper stocking rates, rotation grazing, and timely deferment of grazing help keep the pasture and soil in good condition and maintain the desirable native grass species. If this soil is overgrazed, it is subject to soil blowing. Grazing needs to be controlled to maintain a good vegetative cover.

This soil generally is not suited to trees and shrubs in windbreaks. It is suited to environmental plantings, such as specialized or scalp plantings, but intensive management is needed.

This soil is suited to use as a site for buildings and poorly suited to septic tank absorption fields. Caving or sloughing of the walls of shallow excavations, as for basements, can be prevented by shoring trench walls. Wetness is a problem at building sites. This problem can be overcome by foundation drainage. Because of the rapid permeability and poor filtering characteristics of the soil, effluent from septic tank absorption fields can pollute the ground water. Holding tanks are an alternative to onsite disposal.

This soil is in capability subclass VIe.

62B—Serden loamy fine sand, 0 to 6 percent slopes. This is a level to undulating, excessively drained soil on wind-worked glacial outwash plains. The areas range from 10 to more than 100 acres in size. Slopes are short and choppy.

Typically, the surface layer is very dark gray loamy fine sand about 2 inches thick. The underlying material is fine sand. It is very dark grayish brown in the upper part and grayish brown in the lower part to a depth of 60 inches. In some areas, the soil is moderately well drained.

Permeability is rapid. Runoff is very slow. The content of organic matter and the available water capacity are low.

In most areas, this soil is used as native pasture. This soil is best suited to use as native pasture or hayland. A cover of range or pasture plants is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition and help maintain the desired native grass species. If this soil is overgrazed, it is subject to soil blowing. Grazing needs to be controlled to maintain a good plant cover.

This soil generally is not suited to trees and shrubs in windbreaks. It is suited to specialized or scalp plantings for wildlife habitat, recreation, or beautification, but intensive management is needed.

This soil is well suited to use as building site development and poorly suited to use as septic tank absorption fields. Caving or sloughing of walls in shallow excavations, as for basements, can be prevented by shoring trench walls. Because of the rapid permeability and the poor filtering characteristics of the soil, effluent from septic tank absorption fields can pollute the ground water. Holding tanks are an alternative to onsite disposal.

This soil is in capability subclass VIe.

64B—Towner loamy fine sand, 0 to 6 percent slopes. This is a level to undulating, moderately well drained soil on till or lacustrine plains that are mantled with wind- or water-sorted loamy fine sand. The areas range from 20 to more than 100 acres in size.

Typically, the surface layer is black loamy fine sand about 9 inches thick. The subsurface layer is very dark grayish brown loamy fine sand about 7 inches thick. The underlying material is dark grayish brown loamy fine sand in the upper part and light olive brown loam in the lower part to a depth of 60 inches. In some areas, loamy fine sand extends to a depth of 60 inches.

Permeability is rapid over moderate or moderately slow. Runoff is slow. Soil tilth is fair. The content of organic matter and the available water capacity are moderate. A seasonal high water table is at a depth of 3 to 6 feet.

In most areas, this soil is farmed, but in a few places it is used for pasture or hay. This soil is suited to small grains and flax, but it is poorly suited to sunflowers. It is somewhat droughty because the available water capacity is moderate. Soil blowing is a severe hazard. Tillage that leaves a maximum amount of crop residue on the surface helps to reduce soil blowing. Flax strips or other buffer strips, stripcropping, and windbreaks also are helpful. This soil is particularly well suited to rye because rye is a fall-seeded crop that protects the soil from blowing and makes the best use of the available moisture.

A cover of range, hay, or pasture plants is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is suited to trees and shrubs in windbreaks and as environmental plantings. Many climatically adapted species grow well.

This soil is suited to use as building sites and poorly suited to use as septic tank absorption fields. The shrinking and swelling of the soil and wetness are problems at building sites. These problems can be overcome by providing foundation drainage, reinforcing basement walls, and providing a positive grade of the soil away from the building. Caving or sloughing of the walls of shallow excavations, as for basements, can be prevented by shoring trench walls. The moderately slow permeability is a limitation for septic tank absorption fields, but it can be overcome by enlarging the field. Wetness is a continuing limitation. Holding tanks are an alternative to onsite disposal.

This soil is in capability subclass IVe.

65—Swenoda fine sandy loam, 0 to 3 percent slopes. This is a level and nearly level, moderately well drained soil on till or lacustrine plains that are mantled with wind- or water-sorted fine sandy loam. The areas range from 10 to more than 200 acres in size.

Typically, the surface layer is black fine sandy loam about 7 inches thick. The subsurface layer is very dark gray fine sandy loam about 10 inches thick. The subsoil is dark grayish brown fine sandy loam about 8 inches thick. The underlying material is grayish brown fine sandy loam in the upper part and mottled, light olive brown silt loam in the lower part, to a depth of 60 inches. In some areas, fine sandy loam extends to a depth of 60 inches. In other areas, slopes range from 3 to 6 percent.

Permeability is moderately rapid over moderate or moderately slow. Runoff is slow. Soil tilth is good. The content of organic matter is high. The available water capacity is moderate. A seasonal high water table is at a depth of 2.5 to 4 feet.

In most areas, this soil is farmed. It is well suited to small grains, flax, and sunflowers. This soil is somewhat droughty because of the moderate available water capacity. Soil blowing is a severe hazard. Tillage that leaves a maximum amount of crop residue on the surface helps to reduce soil blowing. Flax strips or other buffer strips, stripcropping, and windbreaks also are helpful. This soil is particularly well suited to rye because rye is a fall-seeded crop that protects the soil from blowing and makes the best use of available moisture.

A cover of pasture, hay, or range plants is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is well suited to trees and shrubs in windbreaks and as environmental plantings. Many climatically adapted species grow well.

This soil is suited to use as building sites and poorly suited to use as septic tank absorption fields. The shrinking and swelling of the soil and wetness are problems at building sites. These problems can be overcome by providing foundation drainage, reinforcing basement walls, and providing a positive grade of the soil away from the building. The moderately slow permeability is a limitation for septic tank absorption fields, but it can be overcome by enlarging the field. Wetness is a continuing limitation. Holding tanks are an alternative to onsite disposal.

This soil is in capability subclass IIIe.

69—Arveson loam. This is a level, poorly drained soil on low-lying flats and in shallow depressions on glacial outwash and lacustrine plains. The areas range from 5 to more than 40 acres in size.

Typically, the surface layer is very dark gray loam about 13 inches thick. The mottled underlying material is dark gray loam in the upper part, olive gray loamy sand in the middle part, and gray fine sand and sand to a depth of 60 inches. In some areas, the soil is very poorly drained.

Included with this soil in mapping are small areas of Stirum soils in similar positions on the landscape. Stirum soils contain sodium in amounts that affect soil structure and the penetration of roots and moisture. They make up about 10 percent of the map unit.

Permeability is moderately rapid. Runoff is very slow. Soil tilth is good. The content of organic matter is high. The available water capacity is moderate. A seasonal high water table is at a depth of 1 foot to 2 feet.

In most areas, this soil is in native grasses that are used for pasture or hay. This soil is poorly suited to small grains, flax, and sunflowers. The seasonal high water table frequently delays tilling and seeding. In most areas, this soil is not drained because suitable outlets are not available. Soil blowing is a moderate hazard and can be

controlled by stripcropping and by tillage that leaves a moderate amount of crop residue on the surface.

A cover of range or pasture plants or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition and maintain the desirable native grasses.

This soil, if it is not drained, generally is not suited to trees and shrubs in windbreaks and as environmental plantings. If suitable outlets are available and the soil is drained, climatically adapted species grow well.

This soil is well suited to use as habitat for wetland wildlife. Most areas are surrounded by soils that are suited to crops and vegetation that provide food for some kinds of wetland wildlife.

This soil generally is not suited to use as building sites and septic tank absorption fields because of wetness and the poor filtering characteristics of the soil. The soil generally is not used as sites for buildings.

This soil is in capability subclass IVw.

71—Arveson loam, wet. This is a level, very poorly drained soil in deep depressions on glacial outwash and lacustrine plains. It is frequently ponded during snowmelt and heavy rains. The areas range from 5 to more than 40 acres in size.

Typically, the surface layer is very dark gray loam about 13 inches thick. The mottled underlying material is dark gray loam in the upper part, olive gray loamy sand in the middle part, and gray fine sand and sand to a depth of 60 inches. In some areas, the soil is poorly drained.

Permeability is moderately rapid. Runoff is ponded. The content of organic matter is high. The available water capacity is moderate. A seasonal high water table is above or near the surface.

In most areas, this soil is in native grasses that are used for pasture or hay. This soil is not suited to small grains, flax, and sunflowers. In most areas, it is not drained because suitable outlets are not available. In some years, the soil is so wet that hay cannot be harvested.

A cover of native plants is effective in controlling erosion. Timely deferment of grazing and restricted use during wet periods help keep the pasture and soil in good condition and maintain the desired plant species. The most suitable season for grazing is late in summer or early in fall.

This soil generally is not suited to trees and shrubs in windbreaks and as environmental plantings. It is too wet for most species to survive.

This soil is well suited to use as habitat for wetland wildlife. Most areas of this soil are surrounded by soils that are suited to crops and vegetation that provide food for some kinds of wetland wildlife.

This soil generally is not suited to use as building sites and septic tank absorption fields because of ponding and the poor filtering characteristics of the soil. This soil generally is not used as a site for buildings.

This soil is in capability subclass Vw.

73—Letcher fine sandy loam, 0 to 3 percent slopes. This is a level and nearly level, moderately well drained soil on glacial outwash plains. The areas range from 5 to more than 150 acres in size.

Typically, the surface layer is black fine sandy loam about 6 inches thick. The subsurface layer is very dark gray fine sandy loam about 3 inches thick. The subsoil is about 19 inches thick. It is very dark grayish brown fine sandy loam in the upper part and mottled, dark grayish brown sandy loam in the lower part. The mottled underlying material is grayish brown sandy loam in the upper part, light olive brown fine sandy loam in the middle part, and light olive brown loamy fine sand to a depth of 60 inches.

Included with this soil in mapping are small areas of Stirum soils. Stirum soils are poorly drained and are in shallow depressions and on low-lying flats. They make up about 10 percent of the map unit.

Permeability is slow. Runoff is slow. Soil tilth is poor. The content of organic matter and the available water capacity are moderate. The dense sodic subsoil restricts rooting depth to about 10 inches. A seasonal high water table is at a depth of 3.5 to 6 feet.

In most areas, this soil is farmed. It is poorly suited to small grains, flax, and sunflowers because the dense subsoil limits the penetration of roots and water. Timely cultivation and additions of organic matter help to improve or maintain soil tilth. Soil blowing is a severe hazard. Tillage that leaves a maximum amount of crop residue on the surface helps to reduce soil blowing. Stripcropping and buffer strips are also helpful.

A cover of range or pasture plants or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition. If the pasture is overgrazed, soil blowing is a hazard. Grazing needs to be controlled to maintain a good plant cover.

This soil is poorly suited to trees and shrubs in windbreaks and as environmental plantings because the dense sodic subsoil impedes root development. A few climatically adapted species survive and grow, but vigor is poor and growth is slow.

This soil is suited to use as building site development and poorly suited to use as septic tank absorption fields. Wetness is a problem at building sites, but this problem can be overcome by foundation drainage. Wetness is a continuing limitation for septic tank absorption fields. Holding tanks are an alternative to onsite disposal.

This soil is in capability subclass IVe.

74B—Cresbard-Svea loams, 0 to 6 percent slopes. This complex consists of level to undulating, moderately well drained soils on till plains in areas that range from

10 to more than 300 acres in size. The Cresbard soil makes up about 60 percent of the complex, and the Svea soil makes up 40 percent. The soils are in similar positions on the landscape and are in areas so intricately mixed that mapping the soils separately was not practical.

Typically, the Cresbard soil has a surface layer of black loam about 6 inches thick. The subsurface layer is very dark grayish brown loam about 2 inches thick. The layer below that, which is also about 2 inches thick, is very dark gray clay loam and very dark grayish brown loam. The subsoil is clay loam about 7 inches thick. It is very dark gray in the upper part and very dark grayish brown in the lower part. The underlying material is dark grayish brown clay loam in the upper part and mottled, dark grayish brown loam in the lower part, to a depth of 60 inches.

Typically, the Svea soil has a surface layer of black loam about 11 inches thick. The subsoil is loam about 21 inches thick. It is very dark gray in the upper part and dark brown in the lower part. The underlying material is olive loam to a depth of 60 inches. The lower part of the subsoil and the underlying material are mottled.

Permeability is moderately slow. Runoff is slow. Soil tilth is fair in the Cresbard soil and good in the Svea soil. The content of organic matter and the available water capacity are moderate in the Cresbard soil and high in the Svea soil. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil.

In most areas, these soils are farmed. They are suited to small grains, flax, and sunflowers. In most years, the growth of crops on the Cresbard soil is adversely affected because the available water capacity is moderate. The claypan in the Cresbard soil restricts root growth. Deep tillage can break up part of the claypan and permit deeper penetration of roots. Soil tilth can be maintained or improved by cultivation when the soil is not too wet or too dry. Soil blowing and water erosion are slight hazards and are easily controlled by stripcropping and by tillage that leaves crop residue on the surface.

A cover of range and pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

The Cresbard soil is suited to trees and shrubs in windbreaks and as environmental plantings, and the Svea soil is well suited. Many climatically adapted species grow well on the Cresbard soil, and all climatically adapted species grow well on the Svea soil.

These soils are suited to use as building sites and septic tank absorption fields. The moderately slow permeability is a limitation for septic tank absorption fields, but this limitation can be overcome by enlarging the field. Wetness is a continuing problem on the Svea soil for septic tank absorption fields. The shrinking and swelling of the soil is a problem at building sites. This problem can be overcome by providing foundation drainage, reinforcing basement walls, and providing a positive grade of the soil away from the building. Wetness is a problem at building sites on the Svea soil, but this problem can be overcome by foundation drainage.

The soils in this complex are in capability subclass IIIs.

75—Aberdeen-Overly silt loams. This complex consists of level, moderately well drained soils on glacial lacustrine plains, in areas that range from 10 to more than 300 acres in size. The Aberdeen soil makes up about 60 percent of the complex, and the Overly soil makes up 40 percent. The soils are in similar positions on the landscape. They are in areas so intricately mixed that mapping the soils separately was not practical.

Typically, the Aberdeen soil has a surface layer of black silt loam about 7 inches thick. The subsurface layer, which is about 2 inches thick, is very dark gray silt loam. Below that, which also is about 2 inches thick, is very dark gray silty clay loam that has dark grayish brown silt coatings. The subsoil is silty clay loam 11 inches thick. It is black in the upper part and very dark grayish brown in the lower part. The underlying material to a depth of 60 inches is dark grayish brown silty clay loam in the upper part, olive brown silty clay loam in the middle part, and mottled, olive brown silt loam in the lower part.

Typically, the Overly soil has a surface layer of black silt loam about 7 inches thick. The subsurface layer is very dark gray silty clay loam about 10 inches thick. The subsoil is dark brown silty clay loam about 13 inches thick. The underlying material to a depth of 60 inches is light olive brown silty clay loam in the upper part, mottled, olive brown silty clay loam in the middle part, and mottled, olive brown silty clay in the lower part.

Permeability is slow in the Aberdeen soil and moderately slow in the Overly soil. Runoff is slow. Soil tilth is good in the Overly soil and fair in the Aberdeen soil. The content of organic matter and the available water capacity are moderate in the Aberdeen soil and high in the Overly soil. A seasonal high water table is at a depth of 4 to 6 feet in the Aberdeen soil.

In most areas, these soils are farmed (fig. 13). The soils are suited to small grains, flax, and sunflowers. The Aberdeen soil is droughty in some years because the available water capacity is moderate. Its dense sodic subsoil restricts root growth. Deep tillage can break up part of the claypan, allowing better penetration of roots and moisture. Soil tilth can be maintained or improved by timely cultivation. Cultivation should be avoided when the soils are too wet or too dry. Soil blowing is a slight hazard and is easily controlled by tillage that leaves crop residue on the surface and by stripcropping.

Figure 13.—A wheatfield in an area of Aberdeen-Overly silt loams. Crops on the Aberdeen soil are stunted because the dense, sodic subsoil restricts the rooting depth.

A cover of pasture, hay, or range plants is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

The Aberdeen soil is suited to trees and shrubs in windbreaks and as environmental plantings, and the Overly soil is well suited. Many climatically adapted species grow well on the Aberdeen soils, and all climatically adapted species grow well on the Overly soil.

The Aberdeen soil is suited to use as a site for buildings and poorly suited to use as septic tank absorption fields. The Overly soil is suited to use as building sites and septic tank absorption fields. The slow permeability of the Aberdeen soil and the moderately slow permeability of the Overly soil are a limitation for septic tank absorption fields, but this limitation can be overcome by enlarging the field. Wetness on the Aberdeen soil is a continuing problem for absorption fields. The shrinking and swelling of the soil is a problem at building sites. This problem can be overcome by providing foundation drainage, reinforcing basement walls, or providing a positive grade of the soil surface away from the building. On the Aberdeen soil, wetness can be overcome by foundation drainage.

Both soils are in capability subclass IIIs.

79—Divide loam. This is a level, somewhat poorly drained soil in low areas on outwash plains and in channels. The areas range from 3 to more than 30 acres in size.

Typically, the surface layer is black loam about 7 inches thick. The underlying material is gray and light gray loam in the upper part, very dark grayish brown loam in the middle part, and dark yellowish brown gravelly sand in the lower part to a depth of 60 inches. In some areas, a layer of lime accumulation is below a depth of 16 inches.

Permeability is moderate over very rapid. Runoff is slow. Soil tilth is good. The content of organic matter is high. The available water capacity is moderate. A seasonal high water table is at a depth of 2.5 to 5 feet.

In most areas, this soil is farmed. It is suited to small grains, flax, and sunflowers. Spring seeding and tillage are often delayed because of wetness. Soil blowing is a moderate hazard and can be controlled by stripcropping and by tillage that leaves a moderate amount of crop residue on the surface.

A cover of range or pasture plants or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is well suited to trees and shrubs in windbreaks and as environmental plantings. Climatically adapted species grow well.

This soil is suited to use as building sites, but it generally is not suited to use as septic tank absorption fields. Caving or sloughing of the walls of shallow excavations, as for basements, can be prevented by shoring trench walls. Wetness is a problem at building sites. This problem can be overcome by providing foundation drainage. Wetness and the poor filtering characteristics of the soil are continuing limitations for septic tank absorption fields. Holding tanks are an alternative to onsite disposal.

This soil is in capability subclass IIIs.

80—Marysland loam. This is a level, poorly drained soil on low-lying flats and swales on glacial outwash plains and in channels. The areas range from 20 to 50 acres in size.

Typically, the surface layer is loam about 19 inches thick. It is black in the upper part and very dark gray in the lower part. The underlying material is mottled, grayish brown loam in the upper part, mottled, light brownish gray gravelly sand in the middle part, and yellowish brown gravelly sand in the lower part to a depth of 60 inches. In some areas, the soil is saline. In other areas, gravel is at a depth of more than 40 inches.

Permeability is moderate over rapid. Runoff is slow. Soil tilth is good. The content of organic matter is high. The available water capacity is moderate. A seasonal high water table is at a depth of 1 foot to 2.5 feet.

In most areas, this soil is used as pasture or hayland. This soil is poorly suited to small grains, flax, and sunflowers. Wetness delays tilling and seeding in the spring of most years. In most places, drainage is not feasible because there are no suitable outlets. Soil blowing is a moderate hazard and can be controlled by stripcropping and by tillage that leaves a moderate amount of crop residue on the surface.

A cover of range or pasture plants or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil generally is not suited to trees and shrubs in windbreaks and as environmental plantings. If suitable outlets are available and the soil is drained, climatically adapted species grow well.

This soil is well suited to use as habitat for wetland wildlife. Most areas of this soil are surrounded by soils that are suited to crops and vegetation that provide food for some kinds of wetland wildlife.

This soil generally is not suited to use as building sites and septic tank absorption fields because of wetness and poor filtering characteristics. This soil generally is not used for building sites.

This soil is in capability subclass IVw.

82B—Arvilla sandy loam, 0 to 6 percent slopes. This is a level to undulating, somewhat excessively drained soil on long smooth slopes and low ridges and knolls of glacial outwash plains and channels. The areas range from 3 to more than 100 acres in size.

Typically, the surface layer is black sandy loam about 6 inches thick. The subsoil is very dark gray sandy loam about 9 inches thick. The underlying material to a depth of 60 inches is dark brown gravelly sand (fig. 14). In some areas, gravelly sand is at a depth of less than 15 inches.

Permeability is rapid. Runoff is slow. Soil tilth is good. The content of organic matter is moderate. The available water capacity is low.

In most areas, this soil is farmed. It is poorly suited to small grains, flax, and sunflowers. This soil is droughty because the available water capacity is low. Soil blowing is a severe hazard, and water erosion is a slight hazard. Tillage that leaves a maximum amount of crop residue on the surface helps to reduce soil blowing. Buffer strips and stripcropping are also helpful. This soil is particularly well suited to rye because rye is a fall-seeded crop that protects the soil from blowing and makes the best use of available moisture.

A cover of range, hay, or pasture plants is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is poorly suited to trees and shrubs in windbreaks and as environmental plantings.

This soil is well suited to use as a site for buildings and poorly suited to use as septic tank absorption fields. Caving or sloughing of the walls of shallow excavations, as for basements, can be prevented by shoring trench

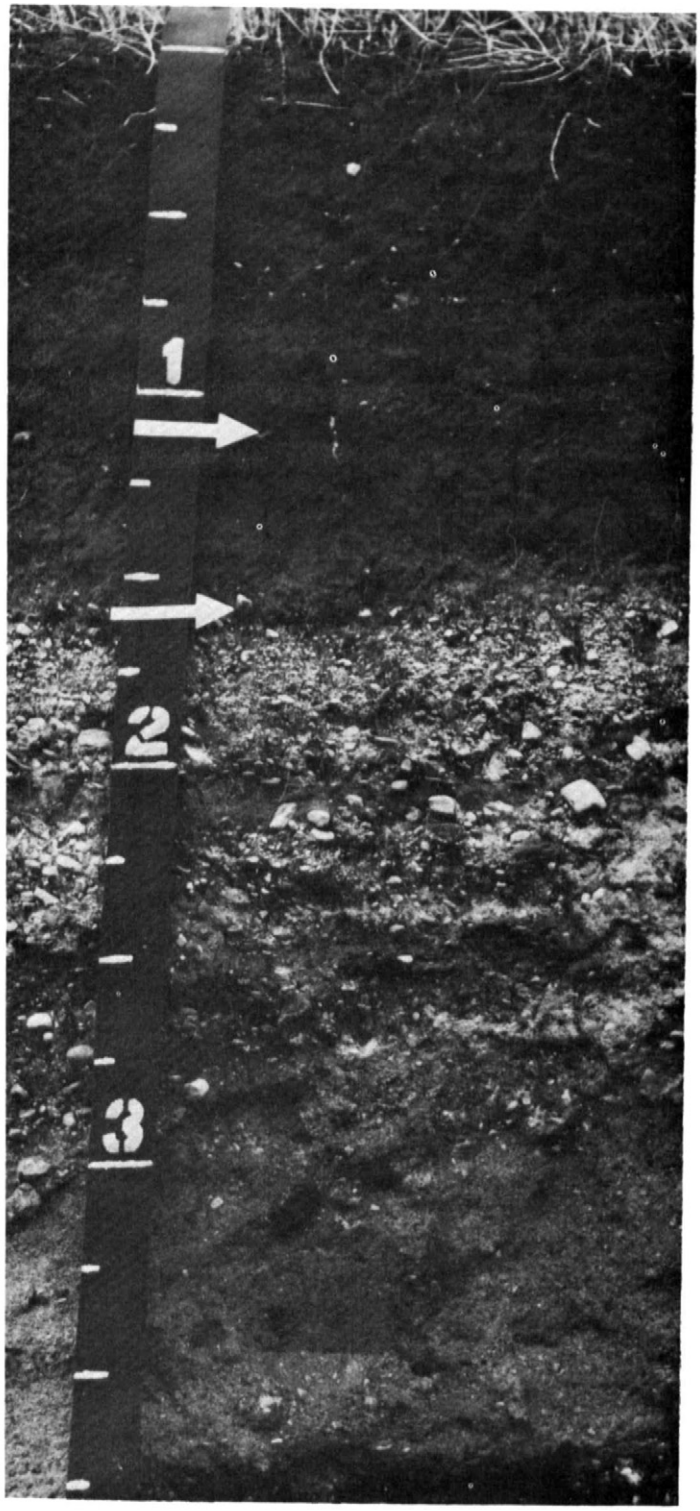


Figure 14.—Profile of Arvilla sandy loam, 0 to 6 percent slopes. The surface layer and subsoil extend to a depth of about 15 inches. The depth to gravelly sand ranges from 14 to 25 inches. Depth is marked in feet.

walls. Because of the rapid permeability and poor filtering characteristics of the soil, effluent from septic tank absorption fields can pollute the ground water. Holding tanks are an alternative to onsite disposal.

This soil is in capability subclass IIIe.

83D—Sioux loam, 0 to 15 percent slopes. This is a level to rolling, excessively drained soil on flats, knolls, and ridges of glacial outwash plains and channels. The areas range from 3 to more than 50 acres in size.

Typically, the surface layer is black loam about 6 inches thick. The next layer is very dark grayish brown sandy loam about 2 inches thick. The underlying material to a depth of 60 inches is dark brown very gravelly sand (fig. 15). In some areas, the surface is very stony. In other areas, gravelly sand is at a depth of more than 14 inches.

Permeability is very rapid. Runoff is slow. The content of organic matter and the available water capacity are low.

In most areas, this soil is used as native grass pasture. It is best suited to range or pasture. A cover of range or pasture plants or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition and help maintain the desired native grasses.

This soil generally is not suited to trees and shrubs in windbreaks and as environmental plantings.

This soil is well suited to use as building sites and poorly suited to use as septic tank absorption fields. The caving or sloughing of the walls of shallow excavations, as for basements, can be prevented by shoring trench walls. Slope is a problem for buildings on the steeper parts of the landscape, but this limitation can be overcome by designing buildings to conform to the natural slope of the land. Land shaping may be necessary in some areas. Because of the rapid permeability and poor filtering characteristics of the soil, effluent from septic tank absorption fields can pollute the ground water. Holding tanks are an alternative to onsite disposal.

This soil is in capability subclass VIs.

86C—Bottineau loam, 3 to 9 percent slopes. This is an undulating and gently rolling, well drained soil on till uplands. The areas range from 25 to more than 200 acres in size.

Typically, the surface layer is black loam about 5 inches thick. It has a 2-inch cover of organic material. The subsoil is about 23 inches thick. It is very dark grayish brown clay loam in the upper part and grayish brown loam in the lower part. The underlying material is light olive brown loam in the upper part and grayish brown loam in the lower part to a depth of 60 inches. In some tilled areas, the surface layer is clay loam. Also, in

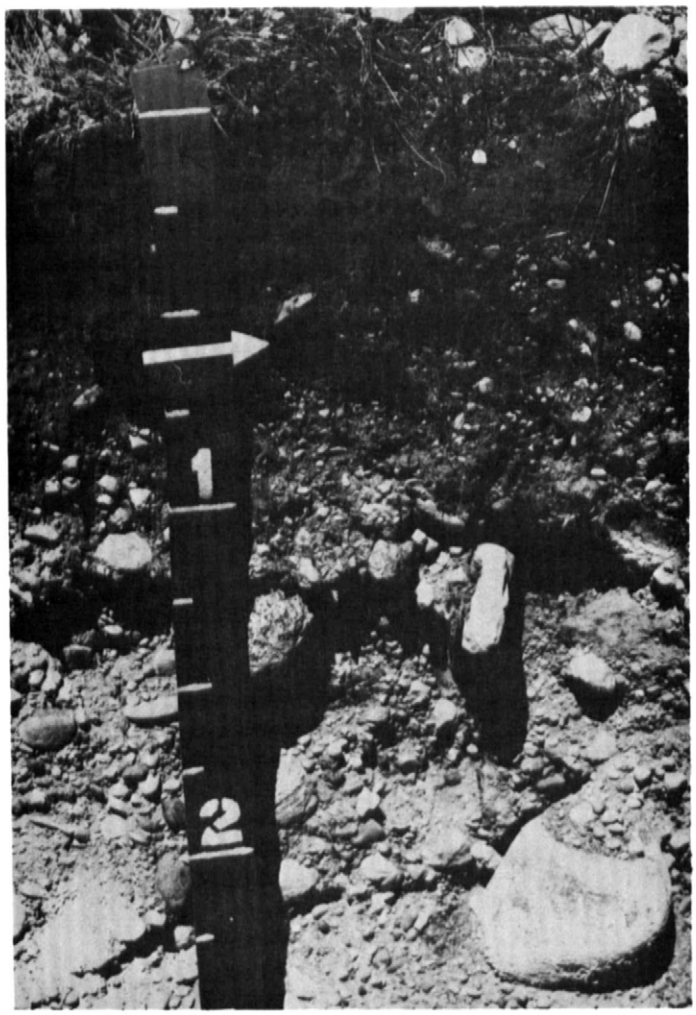


Figure 15.—Profile of Sioux loam, 0 to 15 percent slopes. The arrow marks the boundary between the surface layer and the underlying material. Depth is marked in feet.

other areas, there is a thin, light colored subsurface layer.

Included with this soil in mapping are small areas of the very poorly drained Eramosh soils in deep depressions. The included soils make up about 5 percent of the map unit.

Permeability is moderately slow. Runoff is medium. Soil tilth is good. The content of organic matter and the available water capacity are high.

In most areas, this soil is native woodland and is used for grazing livestock. This soil is suited to small grains and flax. Soil blowing is a slight hazard, and water erosion is a moderate hazard. Erosion can be controlled by tillage that leaves a moderate amount of crop residue on the surface, stripcropping, flax strips or other buffer strips, contour tillage, and close-growing crops.

A cover of range or pasture plants or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is well suited to trees and shrubs in windbreaks and as environmental plantings. Many climatically adapted species grow well.

This soil is suited to use as building sites and septic tank absorption fields. The shrinking and swelling of the soil is a problem at building sites. This problem can be overcome by providing foundation drainage, reinforcing basement walls, and providing a positive grade of the soil away from the building. The moderately slow permeability is a limitation for septic tank absorption fields, but it can be overcome by enlarging the field.

This soil is in capability subclass IIIe.

86E—Bottineau loam, 9 to 25 percent slopes. This is a rolling and hilly, well drained soil on till uplands. The areas range from 50 to more than 300 acres in size.

Typically, the surface layer is black loam about 5 inches thick. It has a 2-inch cover of organic material. The subsoil is about 23 inches thick. It is very dark grayish brown clay loam in the upper part and grayish brown loam in the lower part. The underlying material is light olive brown loam in the upper part and grayish brown loam in the lower part to a depth of 60 inches. In some tilled areas, the surface layer is clay loam. Also, in other areas, there is a thin, light colored subsurface layer.

Included with this soil in mapping are small areas of the very poorly drained Eramosh soils in deep depressions. The included soils make up about 5 percent of the map unit.

Permeability is moderately slow. Runoff is rapid. The content of organic matter and the available water capacity are high.

In most areas, this soil is native woodland and is used for grazing livestock. This soil is not suited to small grains and flax. A cover of range or pasture plants or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil generally is not suited to trees and shrubs in windbreaks. Environmental plantings, for example, scalp or specialized plantings for wildlife, recreation, or beautification, can be made; however, intensive management is needed, and the best adapted species and most favorable sites need to be selected.

This soil is poorly suited to use as building sites and septic tank absorption fields. Slope is a problem at building sites. This problem can be overcome by designing buildings to conform to the natural slope of the land. Land shaping may be needed in some areas. The moderately slow permeability is a limitation for septic tank absorption fields, but it can be overcome by enlarging the field. The less sloping sites should be

selected for septic tank absorption fields. If the steeper slopes are selected, the absorption field needs to be designed to conform to the slope of the land.

This soil is in capability subclass VIe.

87C—Kelvin loam, 3 to 9 percent slopes. This is an undulating and gently rolling, well drained soil on till uplands. The areas range from 15 to more than 200 acres in size.

Typically, the surface layer is very dark grayish brown loam about 5 inches thick. It has a 2-inch cover of organic material. The next layer is very dark grayish brown clay loam and dark brown loam 3 inches thick. The subsoil is 33 inches thick. It is very dark grayish brown clay in the upper part, very dark grayish brown clay loam in the middle part, and dark brown clay loam in the lower part. The underlying material to a depth of 60 inches is light brownish gray clay loam. The middle and lower parts of the subsoil and the underlying material are mottled.

Included with this soil in mapping are small areas of the very poorly drained Eramosh soils in deep depressions. The included soils make up about 5 percent of the map unit.

Permeability is moderately slow. Runoff is medium. Soil tilth is good. The content of organic matter and the available water capacity are high.

In most areas, this soil is native woodland and is used for grazing livestock and as habitat for wildlife. This soil is suited to small grains and flax. Soil blowing is a slight hazard and water erosion is a moderate hazard. Tillage that leaves a moderate amount of crop residue on the surface, stripcropping, flax strips or other buffer strips, contour tillage, and close- growing crops help to control erosion.

A cover of pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is well suited to trees and shrubs in windbreaks and as environmental plantings. Most climatically adapted species grow well.

This soil is suited to use as building sites and septic tank absorption fields. The shrinking and swelling is a problem at building sites. This problem can be overcome by providing foundation drainage, using reinforced basement walls, and providing a positive grade of the soil away from the building. The moderately slow permeability is a limitation for septic tank absorption fields, but it can be overcome by enlarging the field.

This soil is in capability subclass IIIe.

87E—Kelvin loam, 9 to 25 percent slopes. This is a rolling and hilly, well drained soil on till uplands. The areas range from about 50 to more than 300 acres in size.

Typically, the surface layer is very dark grayish brown loam about 5 inches thick. It has a cover of organic material about 2 inches thick. The next layer is very dark grayish brown clay loam and dark brown loam about 3 inches thick. The subsoil is about 33 inches thick. It is very dark grayish brown clay in the upper part, very dark grayish brown clay loam in the middle part, and dark brown clay loam in the lower part. The underlying material to a depth of 60 inches is light brownish gray clay loam. The middle and lower parts of the subsoil and the underlying material are mottled. In most cultivated areas, the surface layer is clay loam.

Included with this soil in mapping are small areas of the very poorly drained Eramosh soils in deep depressions. The included soils make up about 5 percent of the map unit.

Permeability is moderately slow. Runoff is rapid. The content of organic matter is high. The available water capacity is high.

In most areas, the soil is in native woodland and is used for grazing livestock and as habitat for wildlife. This soil is not suited to small grains and flax. A cover of pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil generally is not suited to trees and shrubs in windbreaks. Environmental plantings, for example, scalp or specialized plantings for wildlife, recreation, or beautification, can be made; however, the best adapted species and the most favorable sites need to be selected.

This soil is poorly suited to use as sites for buildings and septic tank absorption fields. Slope is a problem at building sites. This problem can be overcome by designing buildings to conform to the natural slope of the land. Land shaping may be necessary in some areas. The moderately slow permeability is a limitation for septic tank absorption fields, but this limitation can be overcome by enlarging the field and selecting the less sloping sites. If the steeper slopes are selected, the absorption field needs to be designed to conform to the slope of the land.

This soil is in capability subclass VIe.

89B—Rolla silty clay, 0 to 6 percent slopes. This is a level to gently sloping, moderately well drained soil on lacustrine plains. The areas range from 10 to more than 500 acres in size.

Typically, the surface layer is black silty clay about 2 inches thick. It has a 2-inch cover of organic material. The subsurface layer is dark grayish brown silty clay about 10 inches thick. The subsoil is about 20 inches thick. It is dark gray clay in the upper part and dark grayish brown clay in the lower part. The underlying material to a depth of 60 inches is dark grayish brown clay.

Permeability is slow. Runoff is medium. Soil tilth is

Figure 16.—Alfalfa and small grains on Rolla silty clay, 0 to 6 percent slopes. This soil is on a glacial lacustrine plain.

poor. The content of organic matter and the available water capacity are high.

In most areas, this soil is farmed (fig. 16). It is well suited to small grains, alfalfa, and flax. This soil can be tilled only within a narrow range of moisture content because it is very sticky when wet and very hard when dry. Fall tillage and the effects of freezing, thawing, wetting, and drying in winter help to improve tilth. Fall plowing leaves the soil in good condition for seedbed preparation in spring, but it also increases the hazard of soil blowing. Soil blowing can be controlled by flax strips or other buffer strips or by tillage that leaves crop residue on the surface.

A cover of pasture plants or hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is suited to trees and shrubs in windbreaks and as environmental plantings. Many climatically adapted species grow well.

This soil is poorly suited to use as building sites and septic tank absorption fields. The shrinking and swelling of the soil is a problem at building sites. This problem can be overcome by providing foundation drainage, reinforcing basement walls, and providing a positive grade of the soil away from the building. The slow permeability is a limitation for septic tank absorption fields; it is difficult to overcome. Holding tanks are an alternative to onsite disposal.

This soil is in capability subclass IIe.

90E—Bottineau-Buse loams, 9 to 25 percent slopes. This complex consists of rolling and hilly, well drained soils on till uplands in areas that range from 5 to more than 700 acres in size. Bottineau soil makes up about 55 percent of the complex, and Buse soil makes up 40 percent. The Bottineau soil is on the lower part of side slopes, and the Buse soil is on the upper part of side slopes and on hilltops and ridge crests. These soils are in areas so intricately mixed that mapping the soils separately was not practical.

Typically, the Bottineau soil has a 2-inch cover of organic material. The surface layer is black loam about 5 inches thick. The subsoil is about 23 inches thick. It is very dark grayish brown clay loam in the upper part and grayish brown loam in the lower part. The underlying

material is loam. It is light olive brown in the upper part and grayish brown in the lower part to a depth of 60 inches. In some tilled areas, the surface layer is clay loam. In other areas, the upper part of the subsoil is loam.

Typically, the Buse soil has a surface layer of very dark gray loam about 7 inches thick. The underlying material is dark grayish brown loam in the upper part, brown clay loam in the middle part, and grayish brown clay loam in the lower part to a depth of 60 inches. In some cultivated areas, the surface layer is very thin and is light colored.

Included with these soils in mapping are small areas of the very poorly drained Eramosh soils in deep depressions. The included soils make up about 5 percent of the mapped areas.

Permeability is moderately slow. Runoff is rapid. The content of organic matter is high in the Bottineau soil and moderate in the Buse soil. The available water capacity is high.

In most areas, the soils are mixed rangeland and native woodland. These soils are not suited to small grains and flax. A cover of pasture or range plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and soil in good condition.

These soils generally are not suited to trees and shrubs in windbreaks. Environmental plantings, for example, scalp or specialized plantings for wildlife, recreation, or beautification, can be made; however, they require intensive management. The best adapted species and most favorable sites should be selected.

These soils are poorly suited to use as building sites and septic tank absorption fields. Slope is a problem for buildings, but this problem can be overcome by designing buildings to conform to the natural slope of the land. Land shaping may be necessary in some areas. The moderately slow permeability is a limitation for septic tank absorption fields, but this limitation can be overcome by enlarging the field. The less sloping soils should be selected for septic tank absorption fields. If the steeper soils are used for this purpose, the absorption field needs to be designed to conform to the natural slope.

The soils making up this complex are in capability subclass VIe.

94C—Metigoshe coarse sandy loam, 3 to 9 percent slopes. This is an undulating and gently rolling, well drained soil in outwash areas. The areas range from 10 to more than 50 acres in size.

Typically, the surface layer is black coarse sandy loam about 5 inches thick that has a cover of organic material about 2 inches thick. The subsurface layer is very dark grayish brown loamy coarse sand about 3 inches thick. The subsoil, which is also about 3 inches thick, is very dark grayish brown coarse sandy loam. The underlying material is dark grayish brown gravelly loamy coarse sand in the upper part and grayish brown gravelly coarse sand in the lower part, to a depth of 60 inches. In some areas, the surface layer is loam.

Included with this soil in mapping are small areas of Kelvin soils. Kelvin soils are well drained and formed in till. They make up about 10 percent of the map unit.

Permeability is moderate over very rapid. Runoff is medium. Soil tilth is good. The content of organic matter is moderate. The available water capacity is low.

In most areas, this soil is native woodland and is used for grazing livestock or as habitat for wildlife. This soil is poorly suited to small grains and flax. It is droughty because the available water capacity is low. Soil blowing is a severe hazard, but it can be controlled by tillage that leaves a large amount of crop residue on the surface and by stripcropping. Water erosion is a hazard on the steeper slopes. It can be controlled by contour tillage and close-growing crops.

A cover of pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is suited to trees and shrubs in windbreaks and as environmental plantings. Many climatically adapted species grow well.

This soil is suited to use as a site for buildings and poorly suited to septic tank absorption fields. The caving or sloughing of walls in shallow excavations, as for basements, can be prevented by shoring trench walls. Because of the very rapid permeability and poor filtering characteristics of the soil, effluent from septic tank absorption fields can contaminate the ground water. Holding tanks are an alternative to onsite disposal.

This soil is in capability subclass IVe.

94E—Metigoshe coarse sandy loam, 9 to 25 percent slopes. This is a rolling and hilly, well drained soil in outwash areas. Areas of this soil range from 10 to more than 100 acres in size.

Typically, the surface layer is black coarse sandy loam about 5 inches thick that has a cover of organic material about 2 inches thick. The subsurface layer is very dark grayish brown loamy coarse sand about 3 inches thick. The subsoil is very dark grayish brown coarse sandy loam about 3 inches thick. The underlying material to a depth of 60 inches is dark grayish brown gravelly loamy coarse sand in the upper part and grayish brown gravelly coarse sand in the lower part. In some areas, the surface layer is loam.

Included with this soil in mapping are small areas of Kelvin soils. Kelvin soils are well drained and formed in till. They make up about 10 percent of the map unit.

Permeability is moderate over very rapid. Runoff is rapid. The content of organic matter is moderate. The available water capacity is low.

In most areas, this soil is native woodland and is used

for grazing livestock or as habitat for wildlife. This soil is not suited to small grains and flax. This soil is best used as pasture or for hay. Either of these uses is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil generally is not suited to trees and shrubs grown as windbreaks. Environmental plantings, for example, scalp or specialized plantings for wildlife, recreation, or beautification, can be made but require intensive management. The best adapted species and most favorable sites need to be selected.

This soil is poorly suited to use as a site for buildings and generally is not suited to septic tank absorption fields. The caving or sloughing of walls in shallow excavations, as for basements, can be overcome by shoring trench walls. Slope is a problem for buildings, which need to be designed to conform to the natural slope. Land shaping may be needed in some areas. Because of the very rapid permeability and poor filtering characteristics of the soil, effluent from septic tank absorption fields can contaminate the ground water. Holding tanks are an alternative to onsite disposal.

This soil is in capability subclass VIe.

97—Aberdeen-Exline silt loams. This complex consists of level soils on glacial lacustrine plains, in areas that range from 5 to more than 75 acres in size. It is about 50 percent Aberdeen soil and about 50 percent Exline soil. The Aberdeen soil is moderately well drained, and the Exline soil is somewhat poorly drained. The Exline soil is in slight depressions, and the Aberdeen soil is on slight rises. In many areas this slight relief has been obliterated by cultivation. These soils are in areas so intricately mixed that mapping the soils separately was not practical.

Typically, the Aberdeen soil has a surface layer of black silt loam about 7 inches thick. The subsurface layer is very dark gray silt loam about 2 inches thick. The next layer, which is also about 2 inches thick, is very dark gray silty clay loam that has dark grayish brown silt coatings. The subsoil is silty clay loam about 11 inches thick. It is black in the upper part and very dark grayish brown in the lower part. The underlying material is dark grayish brown silty clay loam in the upper part, olive brown silty clay loam in the middle part, and mottled, olive brown silt loam to a depth of 60 inches.

Typically, the Exline soil has a surface layer of very dark gray silt loam about 3 inches thick. The subsoil is silty clay loam about 9 inches thick. It is very dark gray in the upper part and dark grayish brown and very dark grayish brown in the lower part. The underlying material is light olive brown silty clay loam in the upper part, mottled, olive brown silty clay loam in the middle part, and mottled, very dark grayish brown silty clay to a depth of 60 inches.

Permeability and runoff are slow in the Aberdeen soil and very slow in the Exline soil. Soil tilth is fair in the Aberdeen soil and poor in the Exline soil. The content of organic matter and the available water capacity are moderate. A seasonal high water table is at a depth of 2.5 to 4 feet in the Exline soil and 4 to 6 feet in the Aberdeen soil.

In most areas, these soils are farmed, but in some places they are used for hay and pasture. These soils are poorly suited to small grains, flax, and sunflowers. They are droughty in most years because the available water capacity is moderate. Root growth is restricted by the presence of a claypan and the content of salts. Soil tilth is difficult to maintain. Tillage should be avoided when the soils are too wet or too dry. Soil blowing is a slight hazard and can be controlled by tillage that leaves crop residue on the surface and by stripcropping.

A cover of range, hay, or pasture plants is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

The Aberdeen soil is suited to trees and shrubs in windbreaks and as environmental plantings. Many climatically adapted species grow well. The Exline soil generally is not suited to trees and shrubs in windbreaks and as environmental plantings.

The Aberdeen soil is suited to building site development and poorly suited to septic tank absorption fields. The Exline soil generally is not suited to building site development and septic tank absorption fields. The Exline soil is not used as a site for buildings. The slow permeability is a limitation for septic tank absorption fields on the Aberdeen soil, but this limitation can be overcome by enlarging the field. Wetness is a continuing limitation for septic tank absorption fields on the Aberdeen soil. The shrinking and swelling of the soil is a problem for buildings, but this limitation can be overcome by providing foundation drainage, reinforcing basement walls, and providing a positive grade of the soil away from the building. Wetness is a problem for buildings on the Aberdeen soil, but it can be overcome by foundation drainage.

These soils are in capability subclass IVs.

100—Colvin silty clay loam, channeled. This is a level, poorly drained soil on bottom lands adjacent to intermittent drainage channels. It is subject to flooding, and sometimes the surface is covered with water for a long period. The areas range from 50 to more than 300 acres in size. They are dissected by natural drainage channels that are too wet or too deep to cross with machinery.

Typically, the surface layer is black silty clay loam about 8 inches thick. The underlying material is silty clay loam. It is dark gray in the upper part, gray in the middle part, and mottled, grayish brown in the lower part to a depth of 60 inches. In some areas, the surface layer is silt loam. In other areas, the surface layer contains less

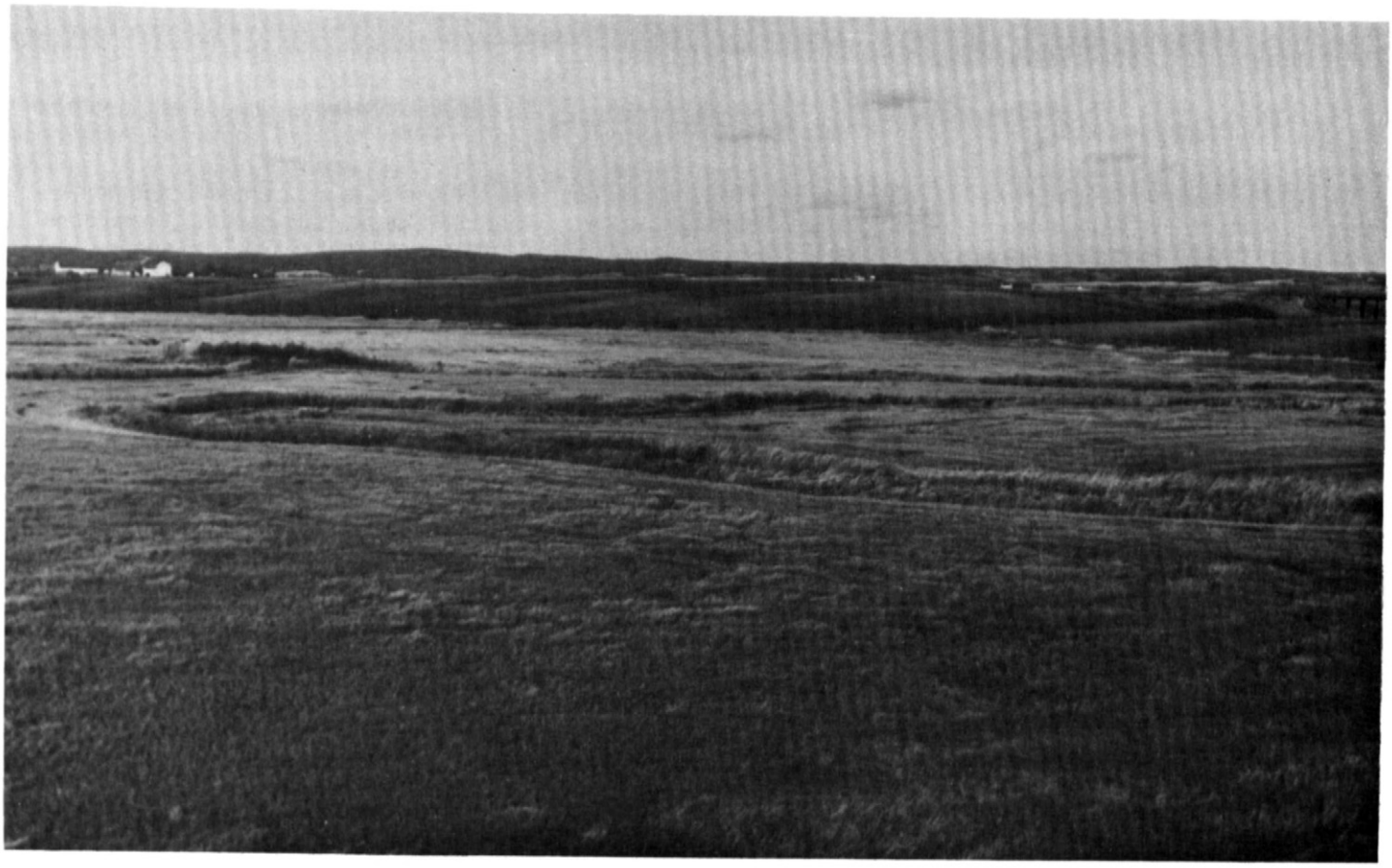


Figure 17.—Native grass pasture on Colvin silty clay loam, channeled.

lime. Also, in a few areas, the soil is slightly to moderately saline.

Permeability is moderately slow. Runoff is very slow. The content of organic matter and the available water capacity are high. A seasonal high water table is above or near the surface.

In most areas, this soil is in native grasses and is used for pasture or hay (fig. 17). This soil is not suited to small grains, flax, and sunflowers because of wetness, flooding, and the presence of channels. It generally is not drained because suitable outlets are not available.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition and maintain the desired native plant species.

The soil generally is not suited to trees and shrubs in windbreaks and as environmental plantings. Flooding and the high water table are difficult to overcome because drainage outlets are not available.

The soil is well suited to use as habitat for wetland wildlife. In most places, the surrounding soils are well suited to crops and vegetation that provide food for some kinds of wetland wildlife.

This soil generally is not suited to building site development and septic tank absorption fields because of flooding, wetness, and the moderately slow permeability. The soil generally is not used as a site for buildings.

This soil is in capability subclass Vw.

103—Eramosh peat, ponded. This is a level, very poorly drained soil in deep depressions on till plains. It is continuously ponded except in some years for short periods. The areas range from 3 to more than 50 acres in size.

Typically, the organic surface layer is about 8 inches thick. It is very dark brown peat in the upper part and black muck in the lower part. The mineral subsurface layer is very dark grayish brown silt loam about 8 inches thick. The underlying material to a depth of 60 inches is silt loam. It is grayish brown in the upper part, very dark grayish brown in the middle part, and gray in the lower part.

Permeability is moderate. Runoff is ponded. The

content of organic matter is very high. The available water capacity is high. A seasonal high water table is above or near the surface.

In most areas, this soil is used as habitat for wetland wildlife. It is well suited to this use. In most places, the surrounding soils are well suited to crops and vegetation that provide food for some kinds of wetland wildlife.

This soil generally is not suited to building site development and septic tank absorption fields. The soil generally is not used as a site for buildings.

This soil is in capability subclass VIIIw.

104—Parnell silty clay loam, ponded. This is a level, very poorly drained soil in deep depressions on till and lacustrine plains and bottom lands. It is continuously ponded except in some years for short periods. The areas range from 3 to more than 500 acres in size.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsoil is silty clay about 30 inches thick. It is black in the upper part and very dark gray in the lower part. The underlying material is olive gray and is mottled. It is silty clay in the upper part and silty clay loam in the lower part to a depth of 60 inches.

Permeability is slow. Runoff is ponded. The content of organic matter is high. The available water capacity is high. A seasonal high water table is above or near the surface.

In most areas, this soil is used as habitat for wetland wildlife. It is well suited to this use (fig. 18). In most places, the surrounding soils are well suited to crops and vegetation that provide food for some kinds of wetland wildlife.

This soil generally is not suited to use as building sites and septic tank absorption fields because of ponding and the slow permeability. The soil generally is not used as a site for buildings.

This soil is in capability subclass VIIIw.

110—Exline silt loam. This is a level, somewhat poorly drained soil on low terraces and flats and in areas adjacent to drainageways. The areas range from 5 to more than 400 acres in size.

Typically, the surface layer is very dark gray silt loam about 3 inches thick. The subsoil is silty clay loam about 9 inches thick. It is very dark gray in the upper part and dark grayish brown and very dark grayish brown in the lower part. The underlying material is light olive brown silty clay loam in the upper part, mottled, olive brown silty clay loam in the middle part, and mottled, very dark grayish brown silty clay to a depth of 60 inches. In some small areas, the soil is poorly drained, and in other areas, it is moderately well drained. Also, in a few areas, it is strongly saline.

Permeability and runoff are very slow. The available water capacity and the content of organic matter are moderate. A seasonal high water table is at a depth of 2.5 to 4 feet.

In most areas, this soil is used for hay or pasture. It is best suited to these uses. These uses are effective in controlling erosion. The salts and sodium in the soil inhibit plant growth. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition and maintain the desired native plant species.

This soil generally is not suited to trees and shrubs in windbreaks and as environmental plantings because of the sodium and soluble salts in the soil.

This soil generally is not suited to building site development and septic tank absorption fields because of wetness, the shrinking and swelling of the soil, and the very slow permeability. The soil generally is not used as a site for buildings.

This soil is in capability subclass VIs.

111—Stirum fine sandy loam. This is a level, poorly drained soil in slight depressions on glacial outwash plains. Small mounds and swales a few feet in diameter are characteristic of some areas. This soil is occasionally ponded during snowmelt and during heavy rains. The areas range from 5 to more than 200 acres in size.

Typically, the surface layer is very dark gray fine sandy loam about 4 inches thick. The subsurface layer is very dark gray fine sandy loam about 6 inches thick. The subsoil is dark gray fine sandy loam about 18 inches thick. The underlying material is light yellowish brown loamy fine sand in the upper part, light olive brown loamy fine sand in the middle part, and olive yellow loamy sand to a depth of 60 inches. The subsoil and the underlying material are mottled.

Permeability is moderately slow over moderate to rapid. Runoff is very slow. The content of organic matter is moderate. The available water capacity is low. A seasonal high water table is above or near the surface.

In most areas, this soil is in native grasses that are used for pasture and hay. This soil is not suited to small grains and flax because of wetness, poor tilth, a severe hazard of soil blowing, and low productivity.

A cover of range or pasture plants or of hay is effective in controlling erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help keep the pasture and soil in good condition and help to maintain the desired native plant species.

This soil generally is not suited to trees and shrubs in windbreaks and as environmental plantings because of wetness, the low available water capacity, and the content of salts.

This soil generally is not suited to building site development and septic tank absorption fields because of ponding and poor filtering characteristics. The soil generally is not used as a site for buildings.

This soil is in capability subclass VIw.

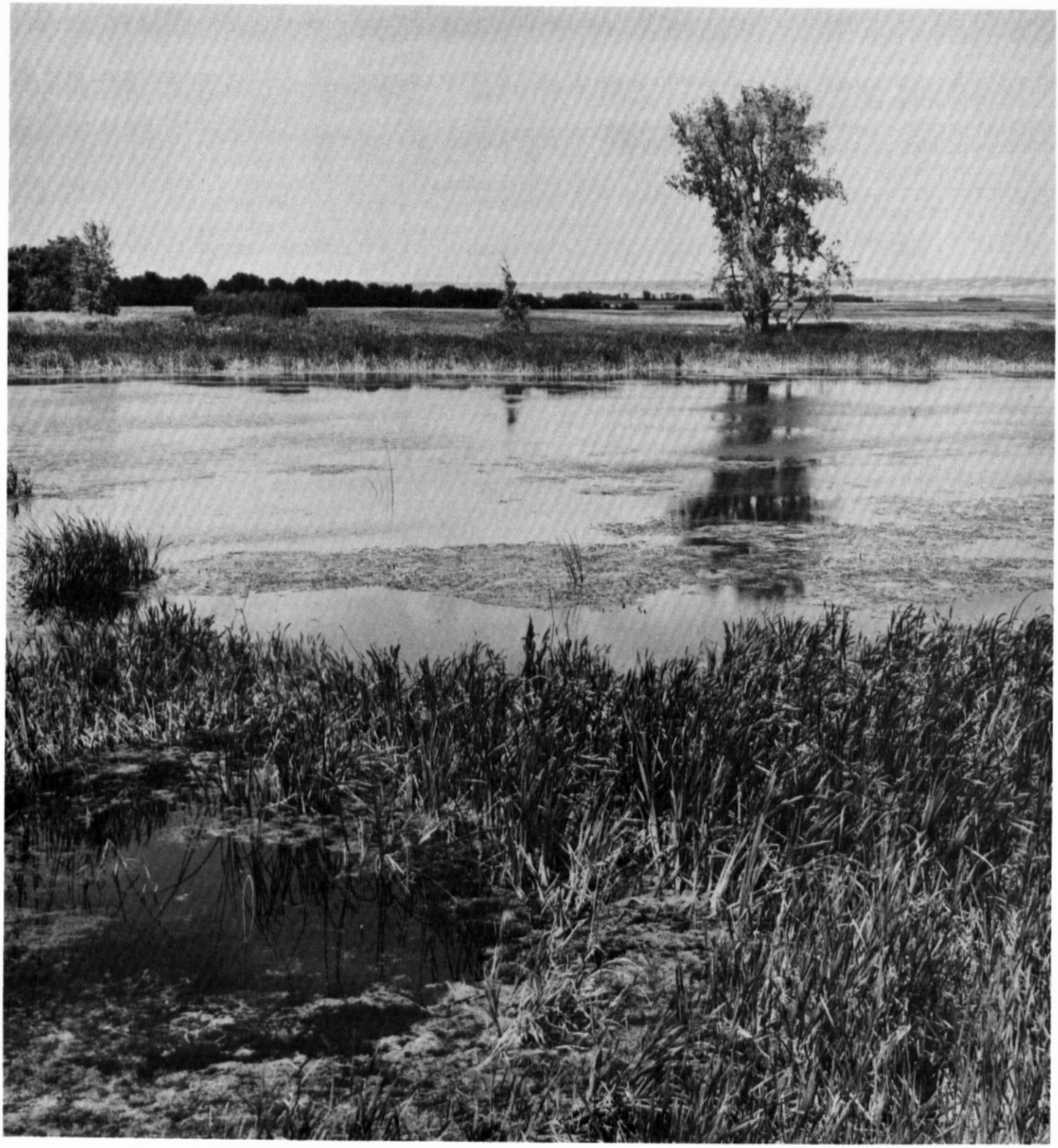


Figure 18.—Parnell silty clay loam, ponded, is used mainly as habitat for wetland wildlife.

116C—Serden-Hecla-Blownout land complex, 0 to 9 percent slopes. This complex consists of level to gently rolling soils and Blownout land on glacial outwash plains. The Serden soil is excessively drained, and the Hecla soil is moderately well drained. The Serden soil makes up 30 to 40 percent of the complex, the Hecla soil 30 to 40 percent, and Blownout land 20 to 30 percent. The areas range from 20 to about 100 acres in size. These soils have undergone very severe soil blowing that has created many shallow depressions in which the water table has been exposed. Adjacent to the shallow depressions are ridges that are nearly barren of vegetation.

Typically, the Serden soil has a surface layer of very dark gray loamy fine sand about 2 inches thick. The underlying material to a depth of 60 inches is fine sand. It is very dark grayish brown in the upper part and grayish brown in the lower part.

Typically, the Hecla soil has a surface layer of black loamy fine sand about 14 inches thick. The subsurface layer is very dark gray loamy fine sand about 7 inches thick. The underlying material to a depth of 60 inches is very dark grayish brown loamy fine sand in the upper part and dark grayish brown fine sand in the lower part. It is mottled from a depth of 39 to 48 inches.

Permeability is rapid. Runoff is very slow on the Serden soil and slow on the Hecla soil. The content of organic matter is low. The available water capacity is low. A seasonal high water table is at a depth of 3 to 6 feet in the Hecla soil.

In most areas, the soils are used as native grass pasture. These soils are not suited to small grains, flax, and sunflowers. Soil blowing is a very severe hazard, and the soils are droughty because the available water capacity is low. They are best suited to use as rangeland or pasture. A cover of range or pasture plants is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition and help maintain the desired native grasses. If these soils are overgrazed, they are subject to soil blowing. Grazing should be controlled to maintain a good plant cover.

These soils generally are not suited to trees and shrubs in windbreaks. They are suited to specialized or scalp plantings for wildlife habitat, recreation, or beautification. The young trees require intensive management to survive and grow well.

The Serden and Hecla soils are suited to building site development and poorly suited to septic tank absorption fields. The caving or sloughing of walls in shallow excavations, as for basements, can be prevented by shoring trench walls. Wetness of the Hecla soil is a limitation for buildings but can be overcome by providing foundation drainage. Because of the rapid permeability, effluent from septic tank absorption fields can pollute the ground water. Holding tanks are an alternative to onsite disposal. Blownout land generally is not suited to building site development or septic tank absorption fields.

These soils are in capability subclass VIe.

prime farmland

In this section, prime farmland is defined and discussed, and the prime farmland soils in the Bottineau County are listed.

Each year thousands of acres of land throughout the United States are converted from agricultural to industrial, urban, and other uses. Some of the converted land is prime farmland.

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in providing the nation's short- and long-range needs for food and fiber. The acreage of high-quality farmland is limited, and the U.S. Department of Agriculture recognizes that government at local, state, and federal levels, as well as individuals, must encourage and facilitate the wise use of our nation's prime farmland.

Prime farmland soils, as defined by the U.S. Department of Agriculture, are soils that are best suited to producing food, feed, forage, fiber, and oilseed crops. Such soils have soil properties that are favorable for the economic production of sustained high yields of crops. The soils need only to be treated and managed using acceptable farming methods. The moisture supply, of course, must be adequate, and the growing season has to be sufficiently long. Prime farmland soils produce the highest yields with minimal inputs of energy and economic resources, and farming these soils results in the least damage to the environment.

Prime farmland soils may presently be used as cropland, pasture, or woodland, or they may be in other uses. They are either used for producing food or fiber or are available for these uses. Urban and built-up land or water areas cannot be considered prime farmland.

Prime farmland soils usually get an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The acidity or alkalinity level of the soils is acceptable. The soils have few or no rocks and are permeable to water and air. They are not excessively erodible or saturated with water for long periods and are not flooded frequently during the growing season. The slope ranges mainly from 0 to 5 percent.

Soils that have a high water table, are subject to flooding, or are droughty may qualify as prime farmland soils if the limitations are overcome by drainage, flood control, or irrigation. Onsite evaluation is necessary to determine the effectiveness of corrective measures.

More information on the criteria for prime farmland soils can be obtained at the local office of the Soil Conservation Service.

prime farmland in Bottineau County

About 604,260 acres, or nearly 55 percent of the county, is prime farmland. A recent trend in land use in some parts of the county has resulted in the loss of some prime farmland to urban and industrial uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, difficult to cultivate, and less productive than prime farmland.

The following map units, or soils, make up prime farmland in Bottineau County. Restrictions are shown in parentheses after the name of the map unit. The location of each map unit is shown on the detailed soil maps at the back of this publication. The extent of each unit is given in table 4. The soil qualities that affect use and management are described in the section 'Detailed soil map units." This list does not constitute a recommendation for a particular land use.

The Hamerly, Bearden, Glyndon, Wyndmere, and Divide soils in the following list are classified as wet soils but do not require drainage to grow the common crops in this county.

1—Tonka silt loam (where drained)
10—Svea loam, 0 to 3 percent slopes
11—Svea-Tonka complex, 0 to 3 percent slopes (where the Tonka soil is drained)
12—Barnes-Svea-Tonka complex, 0 to 3 percent slopes
12B—Barnes-Svea-Tonka complex, 0 to 6 percent slopes
13—Barnes loam, 0 to 3 percent slopes
13B—Barnes loam, 3 to 6 percent slopes
17—Hamerly-Tonka complex, 0 to 3 percent slopes (where drained)
19—Hamerly loam, 0 to 3 percent slopes
21—Vallers loam (where drained)
25—Fargo silty clay (where drained)
27—Hegne silty clay (where drained)
30—Overly silty clay loam
31—Bearden silty clay loam
33—Colvin silty clay loam (where drained)

36—Overly-Great Bend silty clay loams, 0 to 3 percent slopes
40—Gardena silt loam, 0 to 3 percent slopes
42B—Eckman silt loam, 3 to 6 percent slopes
45—Glyndon silt loam
50—Embden fine sandy loam, 0 to 3 percent slopes
53—Wyndmere fine sandy loam
65—Swenoda fine sandy loam, 0 to 3 percent slopes
69—Arveson loam (where drained)
79—Divide loam
80—Marysland loam (where drained)
89B—Rolla silty clay, 0 to 6 percent slopes

use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

crops and pasture

Edward R. Weimer, agronomist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed soil map units." Specific information can be obtained from the local office of the Soil Conservation Service.

According to the United States Department of Agriculture, Agricultural Stabilization and Conservation Service, more than 872,000 acres in Bottineau County was used for crops and pasture in 1979. Of this total, 106,000 acres was in row crops, mainly sunflowers; 421,000 acres was in close-growing crops, mainly wheat, barley, and flax, and some oats and rye; and 232,000 acres was summer fallow.

The acreage in crops has increased, and that in pasture and summer fallow has correspondingly decreased. Sunflower production in the county has increased and is likely to increase in the future.

Some less commonly grown crops that are suited to the soils in the county are corn, rape, potatoes, mustard, millet, and safflower.

The soils in Bottineau County have good potential for increased production of food and fiber. Extending the latest crop production technology to all cropland in the county can help increase yields. Some of this technology includes applying fertilizer at proper rates, using the latest recommended crop varieties, and using pesticides more efficiently.

The main concerns in soil management are controlling soil blowing and water erosion, conserving moisture, and maintaining fertility.

Soil blowing is a hazard on most of the soils in the county, but it is most severe on the sandy Arvilla, Egeland, Embden, Hecla, Maddock, Metigoshe, Swenoda, Towner, Ulen, and Wyndmere soils. It can damage these soils in a very short time if they are farmed in wide, unbroken fields and left without an adequate plant cover. The critical periods for soil blowing are late in the fall and early in summer. Measures that help to control soil blowing are close-growing or cover crops, buffer strips, windbreaks, wind stripcropping, crop residue management, timely use of reduced or minimum tillage, occasional emergency tillage, and grasses and legumes in the cropping system. Generally, several measures are used in combination.

Water erosion is a hazard on the undulating or steeper soils, for example, Barnes, Bottineau, Buse, and Kelvin soils. On slopes of more than 9 percent, the hazard is even more severe. Such steep soils are best used as woodland or kept under a cover of native grasses. Steep soils that are currently used for crops should be converted to grassland. Terraces, crop residue management, and grassed waterways are effective in reducing water erosion.

Soil moisture is conserved by reducing evaporation, limiting runoff, increasing infiltration, and controlling weeds. Measures that control soil blowing and water erosion help to conserve moisture. Periods of fallow help to control weeds and to store moisture in the soil.

Among the measures that help to maintain fertility are the return of crop residue; the application of fertilizer; the plowing down of green manure and spreading of barnyard manure; and the inclusion of cover crops, grasses, and legumes in the cropping system. Most practices that help to control erosion and conserve moisture also maintain or improve fertility.

Other problems in soil management are wetness, surface stones, salinity, a claypan subsoil, and droughtiness. Drainage of most soils that are somewhat poorly drained to very poorly drained can increase yields and the choice of crops. However, in many areas there are no suitable outlets. The effects of salinity can be reduced by eliminating summer fallow; growing the most salt-tolerant crops, grasses, and legumes; and using green manure crops.

Deep plowing can break up and mix the claypan in Aberdeen and Cresbard soils. This results in a lasting improvement and increased yields on these soils. Less permanent improvement is achieved by deep tillage and the use of deep-rooted grasses and legumes. Arvilla, Hecla, and Maddock soils have a low available water capacity. On these soils, continuous cropping, use of fertilizer for the most efficient use of available water, and additions of organic matter have proved effective.

Most of the commonly used conservation practices help to maintain good soil tilth. Clayey soils, such as Fargo and Hegne soils, often are plowed in fall when the moisture content is at the right level to maintain tilth and form a good seedbed.

Some concerns in the management of pasture and hayland are maintenance of the desired species and the optimal plant composition, maintenance of fertility, and proper grazing use or timely harvest. Suitable species include bromegrass, crested wheatgrass, Russian wildrye, and alfalfa. Creeping foxtail and reed canarygrass are adapted to wet sites, and tall, slender, and western wheatgrasses to saline sites.

yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have slight limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed soil map units."

native woodland, windbreaks, and environmental plantings

Elmer R. Umland, forester, Soil Conservation Service, helped prepare this section.

Bottineau County has about 78,000 acres of native woodland. Of this total, 77,000 acres is in the Turtle Mountains. The remaining 1,000 acres is in scattered areas south of Willow City and along Antler Creek.

The largest acreage of woodland in the Turtle Mountains is on Kelvin, Metigoshe, and Rolla soils. These soils make up 52,000 acres of woodland from the Canadian border to about 2 miles from the rim of the Turtle Mountains. Quaking aspen is the dominant tree in this area. Several species of willow grow around potholes and small lakes. Green ash, bur oak, common chokecherry, golden currant, American hazel, paper birch, redosier dogwood, American cranberrybush, and several species of hawthorn and raspberry are scattered throughout.

Other areas of woodland in the Turtle Mountains are on Bottineau soils. These areas are in the foothills, along south and west slopes about 2 miles from the rim of the mountains. Bur oak is the dominant tree on the Bottineau soils. Other trees and shrubs are quaking aspen, green ash, boxelder, common chokecherry, Saskatoon serviceberry, staghorn sumac, golden currant, silver buffaloberry, and common snowberry. Silver buffaloberry and common snowberry are the dominant shrubs in open areas on south slopes.

South of Willow City, the major soils in about 600 acres of scattered woodland are Hecla and Serden soils. These stands are made up of quaking aspen, Woods rose, common chokecherry, common snowberry, and several species of willow.

Along Antler Creek, Glyndon soil is the major soil in about 400 acres of woodland. The dominant trees are American elm, green ash, and boxelder. Several species of willow, common chokecherry, Woods rose, and staghorn sumac also grow in this area.

The species composition of the whole of the woodland in Bottineau County is about 88 percent quaking aspen, 10 percent bur oak, and 2 percent other trees. The major threats to these native stands are fire, insects and disease, and clearing for agricultural purposes.

Early settlers used native trees extensively for lumber, fence posts, and fuel. Trees are still cut for these purposes but to a lesser extent. It is estimated that 25,000 board feet of lumber, 2,000 fence posts, and 1,500 cords of fuel wood are now produced annually.

Reforestation is being carried out mainly on lands owned by the state and also on some private land. Most of the plantings are made to renew the forest resource, for aesthetic purposes, and to provide habitat for wildlife.

Windbreaks have been planted in Bottineau County since the days of the first settlers. Most of the early plantings served to protect farmsteads and feedlots. Tree plantings are still needed around many farmsteads; however, the major need for windbreaks is in cultivated areas where soil blowing is a severe hazard. Since the late 1930's, nearly 8,000,000 trees and shrubs have been planted by county farmers on over 10,000 acres. Major assistance in this work was provided by the Soil Conservation Service and the Mouse River and Turtle Mountain Soil Conservation Districts.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops

from wind, hold snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 6 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 6 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

recreation

Erling B. Podoll, biologist, Soil Conservation Service, helped prepare this section.

There are three major public outdoor recreation developments in the county. They are operated by the State Parks System, the State Forest Service, and the city of Bottineau. There are about 20 other recreation locations that are privately operated or have limited access. One private development has facilities for overnight camping.

Land available for recreation uses is well distributed throughout the survey area. There are 6,420 acres of State Forest land, 1,432 acres of State Game Management areas, and 1,842 acres of waterfowl breeding areas. These areas generally are open to the public for birding, hiking, cross-country skiing, and the like. In addition, 19,000 acres of the J. Clark Salyer Refuge is open for many of the same uses, but hunting is restricted. Public fishing areas are available, although access is somewhat restricted on Lake Metigoshe.

The soils of the survey area are rated in table 7 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 7, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 7 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 10 and interpretations for dwellings without basements and for local roads and streets in table 9.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

wildlife habitat

Erling B. Podoll, biologist, Soil Conservation Service, helped prepare this section.

Wildlife populations in Bottineau County have declined substantially since the county was settled. Species

composition has not changed so drastically because a fair diversity of habitat is still preserved.

Important game birds include gray partridge, sharp-tailed grouse, pheasant, ducks, geese (mainly as nonresident populations), and ruffed grouse. Mourning dove populations are high. Extirpated bird species include sandhill crane, whooping crane, bald eagle, common raven, and passenger pigeon.

Important mammals include white-tailed deer, raccoon, mink, badger, striped skunk, coyote, red fox, beaver, muskrat, eastern cottontail, white-tailed jackrabbit, snowshoe hare, and fox squirrel. Extirpated mammals include bison, elk, black bear, grizzly bear, river otter, fisher, swift fox, and gray wolf.

The county has about 175,000 acres of soils that can store water and support wetland plants (*10*). In some areas, the soils associated with wetlands have been drained for other uses. Wetlands are vital for the breeding of waterfowl and provide important habitat for upland game, white-tailed deer, furbearers, and many other birds and mammals.

Public fishing water includes Lake Metigoshe, Antler Creek, Long Lake, Souris River (J. Clark Salyer National Wildlife Refuge), Strawberry Lake, and Pelican Lake. There are only a few private fishpond developments in the county, and the potential for more is limited. The most commonly sought fish are northern pike, walleye, perch, trout, and bullhead.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 8, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, millet, barley, rye, and sunflowers.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are wheatgrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, wheatgrass, and grama.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are silverberry, cranberry, hazel, snowberry, chokecherry, and juneberry.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, saltgrass, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include gray partridge, pheasant, meadowlark, field sparrow, cottontail, and red fox.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include antelope, white-tailed deer, sharp-tailed grouse, meadowlark, and lark bunting.

engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

building site development

Table 9 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made

for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

sanitary facilities

Table 10 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 10 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 10 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope and bedrock can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 10 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a

high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

construction materials

Table 11 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 11, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less

than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

water management

Table 12 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances, such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 16.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

engineering index properties

Table 13 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and their morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as 15 or 20 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 16.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

physical and chemical properties

Table 14 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.
2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.
3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can

be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

soil and water features

Table 15 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 15 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered is local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 15 are the depth to the seasonal high water table; the kind of water table—that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 15.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. An *artesian* water table is under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

engineering index test data

Table 16 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The soil samples were tested by the North Dakota State Highway Department.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are: AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); California bearing ratio—T 193 (AASHTO), D 1883 (ASTM); Shrinkage—T 92 (AASHTO), D 427 (ASTM); Moisture density—T 180 (AASHTO—modified); Particle density—T 100 (AASHTO).

classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*9*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 17, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquoll (*Aqu*, meaning water, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Calciaquolls (*Calci*, meaning calcic horizonation, plus *aquoll*, the suborder of the Mollisols that have an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Calciaquolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, frigid Typic Calciaquolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the underlying material can differ within a series.

soil series and their morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (*8*). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (*9*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed soil map units."

Aberdeen series

The Aberdeen series consists of deep, moderately well drained, slowly permeable soils on lacustrine plains. The soils formed in calcareous, silty lacustrine material. Slope is 0 to 1 percent.

Aberdeen soils are similar to Cresbard soils and are commonly adjacent to Exline, Gardena, and Overly soils. Cresbard soils formed in till and contain more sand than Aberdeen soils. Exline soils have visible salts within a depth of 16 inches. Gardena and Overly soils do not have a natric horizon.

Typical pedon of Aberdeen silt loam, in an area of Aberdeen-Overly silt loams, in a cultivated field, 250 feet north and 390 feet west of the southeast corner of sec. 20, T. 160 N., R. 74 W.

Ap—0 to 7 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; neutral; abrupt smooth boundary.

A2—7 to 9 inches; very dark gray (10YR 3/1) silt loam, light brownish gray (10YR 6/2) dry; moderate medium platy structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; neutral; abrupt smooth boundary.

B&A—9 to 11 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry (B2t); weak medium columnar structure parting to moderate fine and medium angular blocky; very hard, firm, sticky and plastic; dark grayish brown (10YR 4/2) silt coatings on faces of peds, light gray (10YR 7/1) dry (A2); weak thin platy structure; very hard, firm, sticky and plastic; common fine roots; many thin clay films on faces of peds; neutral; clear smooth boundary.

B21t—11 to 16 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) and grayish brown (10YR 5/2) dry; moderate medium prismatic structure parting to strong fine and very fine angular blocky; very hard, very firm, very sticky and very plastic; common fine roots; continuous moderately thick clay films on faces of peds; mildly alkaline; clear smooth boundary.

B22t—16 to 19 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) crushed, dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) dry; moderate medium prismatic structure parting to strong fine and medium angular blocky; very hard, very firm, sticky and plastic; common fine roots; continuous moderately thick clay films on faces of peds; moderately alkaline; clear smooth boundary.

B3ca—19 to 22 inches; very dark grayish brown (2.5Y 3/2) silty clay loam, dark grayish brown (2.5Y 4/2) crushed, light brownish gray (2.5Y 6/2) and grayish brown (2.5Y 5/2) dry; moderate medium prismatic structure parting to weak medium subangular blocky; hard, friable, sticky and plastic; common fine roots; many moderately thick clay films on faces of peds; few fine irregularly shaped soft masses of lime and gypsum crystals; strong effervescence; moderately alkaline; clear wavy boundary.

C1ca—22 to 31 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; massive; slightly hard, friable, slightly sticky and plastic; few fine roots; many medium irregularly shaped soft masses of lime and gypsum crystals; violent effervescence; moderately alkaline; gradual wavy boundary.

C2—31 to 53 inches; olive brown (2.5Y 4/4) silty clay loam, pale yellow (2.5Y 7/4) dry; massive; hard, firm, sticky and plastic; strong effervescence; moderately alkaline; gradual wavy boundary.

C3cs—53 to 60 inches; olive brown (2.5Y 4/4) silt loam, pale yellow (2.5Y 7/4) dry; common fine distinct gray (5Y 5/1) mottles; massive; hard, firm, slightly sticky and slightly plastic; stratified; many large irregularly shaped soft masses of gypsum crystals; strong effervescence; moderately alkaline.

The solum is 19 to 42 inches thick. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The A2 horizon has hue of 10YR, value of 3 or 4 (5 to 7 dry), and chroma of 1 or 2. The B&A horizon has hue of 10YR, value of 3 or 4 (4 or 5 dry), and chroma of 1 or 2. The B2t horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. It is silty clay or silty clay loam. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (6 to 8 dry), and chroma of 2 to 4.

Arveson series

The Arveson series consists of deep, poorly drained and very poorly drained, moderately rapidly permeable soils on glacial outwash or lacustrine plains. The soils formed in loamy and sandy calcareous outwash or lacustrine sediment. Slope is 0 to 1 percent.

Arveson soils are similar to Ulen soils and are commonly adjacent to Embden, Hecla, and Ulen soils. Embden and Hecla soils are moderately well drained, and Ulen soils are somewhat poorly drained. Embden, Hecla, and Ulen soils are on slightly higher positions, and Hecla and Ulen soils contain more sand than the Arveson soils.

Typical pedon of Arveson loam, in a cultivated field, 1,900 feet north and 1,500 feet east of the southwest corner of sec. 14, T. 159 N., R. 75 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; strong effervescence; mildly alkaline; abrupt smooth boundary.

A12ca—7 to 13 inches; very dark gray (10YR 3/1) loam, light gray (2.5Y 6/1) dry; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

C1ca—13 to 21 inches; dark gray (5Y 4/1) loam, light gray (2.5Y 6/1) dry; few medium distinct grayish brown (2.5Y 5/2) mottles; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; few fine irregularly shaped soft masses of

lime; violent effervescence; moderately alkaline; clear wavy boundary.
C2ca—21 to 29 inches; olive gray (5Y 5/2) loamy sand, light gray (5Y 7/2) dry; common medium distinct light olive brown (2.5Y 5/4) mottles; weak medium and fine granular structure; soft, very friable, nonsticky and nonplastic; few fine irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.
C3—29 to 47 inches; gray (5Y 5/1) fine sand, gray (5Y 6/1) dry; many large distinct light olive brown (2.5Y 5/6) mottles; single grain; loose, nonsticky and nonplastic; slight effervescence; mildly alkaline; gradual wavy boundary.
C4—47 to 60 inches; gray (5Y 5/1) sand, gray (5Y 6/1) dry; many large prominent dark brown (7.5YR 4/4) mottles; single grain; loose, nonsticky and nonplastic; slight effervescence; mildly alkaline.

The mollic epipedon is 7 to 16 inches thick. The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 to 6 dry), and chroma of 1. The Cca horizon has hue of 2.5Y or 5Y, value of 4 to 7 (4 to 8 dry), and chroma of 1 or 2. The lower part of the C horizon has hue of 2.5Y or 5Y, value of 5 or 6 (5 to 7 dry), and chroma of 1 or 2. It is fine sand, sand, or fine sandy loam.

Arvilla series

The Arvilla series consists of deep, somewhat excessively drained, rapidly permeable soils on outwash plains and glacial stream terraces. The soils formed in glacial outwash. Slope ranges from 0 to 6 percent.

Arvilla soils are similar to and are commonly adjacent to Sioux soils. Sioux soils do not have a cambic horizon and contain more gravel than Arvilla soils.

Typical pedon of Arvilla sandy loam, 0 to 6 percent slopes, in a hayfield, 1,980 feet south and 440 feet west of the northeast corner of sec. 18, T. 159 N., R. 81 W.

Ap—0 to 6 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak medium granular structure; soft, very friable, slightly sticky and slightly plastic; many fine and medium roots; neutral; clear smooth boundary.
B2—6 to 15 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; soft, very friable, slightly sticky and slightly plastic; common fine and medium roots; neutral; clear wavy boundary.
IIC—15 to 60 inches; dark brown (10YR 4/3) gravelly sand, brown (10YR 5/3) dry; single grain; loose, nonsticky and nonplastic; about 20 percent gravel; strong effervescence; moderately alkaline.

The thickness of the solum, or the depth to gravelly sand, ranges from 14 to 25 inches. The A horizon is loam or sandy loam. It has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The B2 horizon has hue of 10YR or 2.5Y, value of 3 or 4 (3 to 5 dry), and chroma of 1 to 3. In some pedons there is a B3ca or Cca horizon. The IIC horizon is over 10 percent gravel; it commonly averages 20 to 35 percent.

Barnes series

The Barnes series consists of deep, well drained, moderately slowly permeable soils on till plains. These soils formed in till. Slope ranges from 0 to 25 percent.

Barnes soils are similar to Bottineau and Svea soils and are commonly adjacent to Buse, Hamerly, Svea, and Tonka soils. Unlike Barnes soils, Bottineau soils have a layer of clay accumulation in the subsoil. Svea soils have a mollic epipedon more than 16 inches thick and are in swales and on foot slopes. Buse and Hamerly soils do not have a cambic horizon, and Hamerly soils are somewhat poorly drained. Buse soils are on knobs, and Hamerly soils surround depressions. Tonka soils are poorly drained and are in shallow depressions.

Typical pedon of Barnes loam, 0 to 3 percent slopes, in a cultivated field, 105 feet north and 270 feet west of the southeast corner of sec. 29, T. 159 N., R. 83 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium granular structure; slightly hard, friable, slightly sticky and plastic; many very fine and fine roots; neutral; clear smooth boundary.
B2—7 to 17 inches; dark brown (10YR 4/3) loam, brown (10YR 5/3) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and plastic; many very fine and fine roots; few thin clay films on faces of peds; about 5 percent coarse fragments; mildly alkaline; clear wavy boundary.
C1ca—17 to 32 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and plastic; few very fine roots; few irregularly shaped soft masses of lime; about 10 percent coarse fragments; violent effervescence; moderately alkaline; gradual wavy boundary.
C2—32 to 60 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; few medium distinct yellowish brown (10YR 5/6) and gray (5Y 5/1) mottles; massive; hard, firm, sticky and plastic; about 10 percent coarse fragments; strong effervescence; moderately alkaline.

The solum is 10 to 20 inches thick. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The B horizon has hue of 10YR, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 4. It is loam or clay loam. In some places there is a B3 horizon. The Cca horizon has

hue of 2.5Y or 10YR, value of 4 or 5 (5 to 7 dry), and chroma of 2 to 4. The C2 horizon has hue of 2.5Y, value of 3 to 5 (4 to 7 dry), and chroma of 2 to 4.

Bearden series

The Bearden series consists of deep, somewhat poorly drained, moderately slowly permeable soils on glacial lacustrine plains. The soils formed in calcareous lacustrine material. Slope is 0 to 1 percent.

Bearden soils are similar to Glyndon and Hamerly soils and are commonly adjacent to Colvin and Overly soils. Glyndon soils contain less clay than Bearden soils. Hamerly soils contain more sand than Bearden soils. Overly soils are in higher positions and do not have a calcic horizon within a depth of 16 inches. Colvin soils are poorly drained and are in drainageways and on lower lying flats.

Typical pedon of Bearden silty clay loam, in a cultivated field, 700 feet north and 250 feet east of the southwest corner of sec. 20, T. 162 N., R. 75 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to moderate medium granular; slightly hard, friable, sticky and plastic; many fine and medium roots; strong effervescence; moderately alkaline; abrupt smooth boundary.

C1ca—8 to 17 inches; grayish brown (2.5Y 5/2) silty clay loam, light gray (2.5Y 7/2) dry; few fine faint dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; hard, friable, slightly sticky and plastic; common fine roots; few fine irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

C2—17 to 36 inches; olive brown (2.5Y 4/4) silty clay loam, light brownish gray (2.5Y 6/2) dry; few fine faint gray (N 5/0) and common fine distinct strong brown (7.5YR 5/8) mottles; massive; hard, friable, slightly sticky and plastic; many large irregularly shaped nests of gypsum crystals; strong effervescence; moderately alkaline; gradual wavy boundary.

C3—36 to 60 inches; olive gray (2.5Y 5/2) clay loam, light gray (2.5Y 7/2) dry; many medium distinct brown (7.5YR 4/4) mottles; massive; hard, firm, sticky and plastic; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 16 inches thick. The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1. The Cca horizon has hue of 10YR or 2.5Y, value of 4 or 5 (5 to 7 dry), and chroma of 2 to 4. The C horizon has hue of 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4.

Bottineau series

The Bottineau series consists of deep, well drained, moderately slowly permeable soils on glaciated uplands. The soils formed in till. Slope ranges from 3 to 25 percent. The Bottineau soils in this survey area have less clay accumulation in the subsoil than is defined for the series. This difference does not affect their use or behavior.

Bottineau soils are similar to Barnes and Kelvin soils and are commonly adjacent to Barnes, Buse, Eramosh, and Kelvin soils. Unlike Bottineau soils, Barnes and Buse soils do not have a layer of clay accumulation in the subsoil. Eramosh soils have a histic epipedon, are very poorly drained, and are in depressions. Kelvin soils do not have a mollic epipedon.

Typical pedon of Bottineau loam, in an area of Bottineau-Buse loams, 9 to 25 percent slopes, in a woodland, 2,390 feet west and 2,160 feet south of the northeast corner of sec. 16, T. 163 N., R. 76 W.

O1—2 to 1 1/2 inches; very dark grayish brown (10YR 3/2) mostly undecomposed leaves and twigs; neutral; abrupt smooth boundary.

O2—1 1/2 inches to 0; very dark gray (10YR 3/1) decomposed organic litter; weak fine and medium granular structure; soft, very friable, nonsticky and nonplastic; neutral; abrupt smooth boundary.

A1—0 to 5 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure parting to weak fine and medium granular; hard, firm, slightly sticky and slightly plastic; about 5 percent coarse fragments; slightly acid; clear wavy boundary.

B21t—5 to 11 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; moderate fine and very fine angular blocky structure; very hard, very firm, very sticky and very plastic; common very fine and fine continuous pores; continuous moderately thick clay films on faces of peds and lining pores; many uncoated sand grains on faces of peds; about 5 percent coarse fragments; neutral; clear wavy boundary.

B22t—11 to 21 inches; very dark grayish brown (10YR 3/2) clay loam, brown (10YR 5/3) dry; moderate medium prismatic structure parting to moderate fine and medium angular blocky; very hard, very firm, very sticky and very plastic; many very fine and fine continuous pores; continuous moderately thick clay films on faces of peds and lining pores; many uncoated sand grains on faces of peds; about 5 percent coarse fragments; mildly alkaline; gradual wavy boundary.

B3ca—21 to 28 inches; grayish brown (10YR 5/2) loam, light gray (10YR 7/2) dry; moderate medium angular blocky structure; hard, firm, sticky and plastic; many very fine and fine continuous pores; few thin clay films on faces of peds and lining pores; few fine soft

masses of lime; about 10 percent coarse fragments; strong effervescence; mildly alkaline; gradual wavy boundary.

C1ca—28 to 42 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; massive; hard, firm, sticky and plastic; many medium soft masses of lime; about 10 percent coarse fragments; violent effervescence; moderately alkaline; gradual wavy boundary.

C2ca—42 to 60 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; massive; hard, firm, sticky and plastic; common medium soft masses of lime; about 10 percent coarse fragments; strong effervescence; mildly alkaline.

The solum is 16 to 30 inches thick. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The B2 horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 2 or 3. The Cca horizon has hue of 2.5Y, value of 4 or 5 (6 or 7 dry), and chroma of 2 to 4. The lower part of the C horizon is loam or clay loam.

Buse series

The Buse series consists of deep, well drained, moderately slowly permeable soils on convex glacial uplands. The soils formed in till. Slope ranges from 3 to 25 percent.

Buse soils commonly are adjacent to Barnes, Hamerly, Svea, and Tonka soils. Unlike Buse soils, Barnes, Svea, and Tonka soils have a B horizon; they also have a thicker solum than Buse soils. Svea soils are moderately well drained and are on foot slopes. Tonka soils are poorly drained and are in depressions. Hamerly soils are somewhat poorly drained and surround depressions.

Typical pedon of Buse loam, in an area of Buse-Barnes loams, 9 to 25 percent slopes, in a pasture, 200 feet south and 350 feet west of the northeast corner of sec. 4, T. 163 N., R. 77 W.

A1—0 to 7 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate medium and coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and fine roots; neutral; gradual wavy boundary.

C1ca—7 to 25 inches; dark grayish brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common large soft light gray (10YR 7/2) masses of lime; about 10 percent coarse fragments; violent effervescence; moderately alkaline; gradual wavy boundary.

C2ca—25 to 36 inches; brown (10YR 5/3) clay loam, light gray (10YR 7/2) dry; moderate fine subangular blocky structure; slightly hard, friable, sticky and plastic; few very fine roots; common large soft pale brown (10YR 6/3) masses of lime; about 10 percent coarse fragments; violent effervescence; moderately alkaline; gradual wavy boundary.

C3—36 to 60 inches; grayish brown (2.5Y 5/2) clay loam, light brownish gray (2.5Y 6/2) dry; moderate fine subangular blocky structure; hard, friable, sticky and plastic; common medium soft masses of lime; about 10 percent coarse fragments; strong effervescence; moderately alkaline.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The Cca horizon has hue of 10YR, value of 4 or 5 (5 to 7 dry), and chroma of 2 to 4. The lower part of the C horizon has hue of 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. It is loam or clay loam.

Colvin series

The Colvin series consists of deep, poorly drained, moderately slowly permeable soils on low-lying flats, in shallow depressions on glacial lacustrine plains, and in drainageways. The soils formed in silt loam and silty clay loam lacustrine sediment. Slope is 0 to 1 percent.

Colvin soils are similar to Vallers soils and commonly are adjacent to Hegne, Gardena, and Overly soils. Vallers soils contain more sand and Hegne soils contain more clay than Colvin soils. Gardena and Overly soils are moderately well drained, have a B2 horizon, and do not have a calcic horizon within a depth of 16 inches. They are in slightly higher positions than Colvin soils.

Typical pedon of Colvin silty clay loam, channeled, in a pasture, 110 feet south and 1,480 feet west of the northeast corner of sec. 13, T. 162 N., R. 78 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine and medium granular structure; hard, friable, sticky and plastic; many fine and very fine roots and few medium roots; slight effervescence; mildly alkaline; clear wavy boundary.

C1ca—8 to 22 inches; dark gray (5Y 4/1) silty clay loam, gray (5Y 5/1) dry; weak fine granular structure; hard, friable, sticky and plastic; few fine roots; few fine irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C2ca—22 to 47 inches; gray (5Y 5/1) silty clay loam, light gray (5Y 6/1) dry; massive; hard, firm, sticky and plastic; few fine roots; common fine irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C3g—47 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; common fine prominent strong brown (7.5YR 5/8) mottles; massive; very hard, firm, slightly sticky and plastic; common medium irregularly shaped soft masses of lime; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 16 inches thick. The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 or 4 dry), and chroma of 1. In some pedons there is an Aca or ACca horizon. The Cca horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 8 dry), and chroma of 0 to 2. The Cg horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 to 3. The lower part of the C horizon has few to many mottles. Some pedons contain gypsum and soluble salts.

Cresbard series

The Cresbard series consists of deep, moderately well drained, moderately slowly permeable soils on till plains. The soils formed in calcareous till. Slope ranges from 0 to 6 percent. The Cresbard soils in this survey area have less clay in the subsoil than is defined for the series. This difference does not affect their use or behavior.

Cresbard soils are similar to Aberdeen soils and commonly are adjacent to Svea soils. Aberdeen soils formed in lacustrine deposits and contain less sand and more silt than Cresbard soils. Unlike Cresbard soils, Svea soils do not have a natric horizon. They are on foot slopes.

Typical pedon of Cresbard loam, in an area of Cresbard-Svea loams, 0 to 6 percent slopes, in a cultivated field, 2,620 feet north and 165 feet east of the southwest corner of sec. 29, T. 161 N., R. 74 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; neutral; abrupt smooth boundary.

A2—6 to 8 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate thin and medium platy structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; neutral; abrupt wavy boundary.

B&A—8 to 10 inches; very dark gray (10YR 3/1) clay loam (Bt), very dark gray (10YR 3/1) dry; very dark grayish brown (10YR 3/2) loam on faces of peds (A2), grayish brown (10YR 5/2) dry; moderate fine and medium columnar structure parting readily to strong fine and medium angular blocky; hard, firm, sticky and plastic; common very fine roots; neutral; abrupt wavy boundary.

B21t—10 to 13 inches; very dark gray (10YR 3/1) clay loam, very dark gray (10YR 3/1) dry; strong fine and medium prismatic structure parting to strong fine and medium angular blocky; very hard, very firm, very sticky and very plastic; few very fine roots; continuous thick clay films on faces of peds; neutral; clear wavy boundary.

B22t—13 to 17 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to strong fine and medium angular blocky; very hard, very firm, very sticky and very plastic; few very fine roots; many moderately thick clay films on faces of peds; about 5 percent coarse fragments; moderately alkaline; gradual wavy boundary.

C1ca—17 to 26 inches; dark grayish brown (2.5Y 4/2) clay loam, grayish brown (2.5Y 5/2) dry; weak medium subangular blocky structure; hard, friable, sticky and plastic; few very fine roots; common fine irregularly shaped soft masses of lime; about 10 percent coarse fragments; violent effervescence; moderately alkaline; gradual wavy boundary.

C2—26 to 60 inches; dark grayish brown (2.5Y 4/2) loam, grayish brown (2.5Y 5/2) dry; few fine prominent yellowish red (5YR 4/6, dry) mottles; massive; hard, friable, sticky and plastic; few fine irregularly shaped masses of lime; about 10 percent coarse fragments; strong effervescence; moderately alkaline.

The Ap horizon has hue of 10YR, value of 2 or 3 (3 to 4 dry), and chroma of 1. The B2t horizon has hue of 10YR, value of 2 to 4 (3 or 4 dry), and chroma of 1 to 3. The B2t horizon is clay loam or clay. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. It is clay loam or loam.

Divide series

The Divide series consists of deep, somewhat poorly drained, moderately permeable over very rapidly permeable soils on outwash plains. The soils formed in stratified alluvium. Slope is 0 to 1 percent.

Divide soils are similar to Marysland soils and commonly are adjacent to Arvilla soils. Unlike Divide soils, Arvilla soils do not have a calcic horizon within a depth of 16 inches. They are in slightly higher positions and are somewhat excessively drained. Marysland soils are poorly drained. They are in slightly lower positions.

Typical pedon of Divide loam, in a cultivated field, 700 feet west and 1,500 feet south of the northeast corner of sec. 33, T. 159 N., R. 83 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; slight effervescence; moderately alkaline; abrupt smooth boundary.

C1ca—7 to 12 inches; gray (10YR 5/1) and light gray (10YR 6/1) loam, light gray (10YR 6/1) and (10YR 7/1) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; common medium irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

C2ca—12 to 21 inches; very dark grayish brown (2.5Y 3/2) loam, grayish brown (2.5Y 5/2) dry; weak

medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common fine roots; few fine irregularly shaped soft masses of lime; about 10 percent coarse fragments; violent effervescence; moderately alkaline; gradual wavy boundary.

IIC3—21 to 60 inches; dark yellowish brown (10YR 4/4) gravelly sand, light yellowish brown (10YR 6/4) dry; single grain; loose, nonsticky and nonplastic; about 25 percent coarse fragments; slight effervescence; moderately alkaline.

The mollic epipedon is 7 to 16 inches thick. Depth to gravelly sand ranges from 20 to 40 inches. The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1. The Cca horizon has hue of 10YR or 2.5Y, value of 3 to 6 (5 to 8 dry), and chroma of 1 or 2. The IIC horizon has hue of 10YR or 2.5Y, value of 4 or 5 (5 or 6 dry), and chroma of 2 to 4. Coarse fragments range from 10 to 30 percent.

Eckman series

The Eckman series consists of deep, well drained, moderately permeable soils on glacial lacustrine plains. The soils formed in silty lacustrine sediment. Slope ranges from 3 to 6 percent.

Eckman soils are similar to Gardena soils and commonly are adjacent to Egeland, Embden, and Gardena soils. Unlike Eckman soils, Gardena and Embden soils have a mollic epipedon that is more than 16 inches thick. They are in swales. Egeland and Embden soils contain more sand than Eckman soils.

Typical pedon of Eckman silt loam, 3 to 6 percent slopes, in a cultivated field, 450 feet north and 2,250 feet east of the southwest corner of sec. 22, T. 159 N., R. 75 W.

Ap—0 to 6 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate medium granular structure; soft, very friable, slightly sticky and slightly plastic; common fine roots; mildly alkaline; abrupt smooth boundary.

B2—6 to 11 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; soft, very friable, slightly sticky and slightly plastic; common fine roots; mildly alkaline; clear wavy boundary.

B3ca—11 to 14 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak medium prismatic structure parting to weak medium subangular blocky; soft, very friable, slightly sticky and slightly plastic; common fine roots; few fine threads and soft masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C1ca—14 to 28 inches; light olive brown (2.5Y 5/4) silt loam, light yellowish brown (2.5Y 6/4) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few fine roots; common fine irregularly shaped masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C2—28 to 60 inches; light olive brown (2.5Y 5/4) silt loam, light yellowish brown (2.5Y 6/4) dry; common medium distinct yellowish brown (10YR 5/6) mottles; massive; soft, very friable, slightly sticky and slightly plastic; few fine roots; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 16 inches thick. The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1. The B2 horizon has hue of 10YR, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 4. The Cca horizon has hue of 2.5Y or 10YR, value of 5 or 6 (6 to 8 dry), and chroma of 2 to 4.

Egeland series

The Egeland series consists of deep, well drained, moderately rapidly permeable soils on sandy uplands. The soils formed in glacial outwash sediment. Slope ranges from 3 to 6 percent.

Egeland soils are similar to Embden soils and commonly are adjacent to Eckman, Embden, Gardena, Hecla, and Swenoda soils. Unlike Egeland soils, Embden, Gardena, and Swenoda soils have a mollic epipedon that is more than 16 inches thick. They are in swales. Gardena and Eckman soils contain more silt and less sand than Egeland soils. Hecla soils contain more sand than Egeland soils. Swenoda soils have a contrasting IIC horizon between depths of 22 and 40 inches.

Typical pedon of Egeland fine sandy loam, 3 to 6 percent slopes, in a cultivated field, 300 feet north and 1,848 feet west of the southeast corner of sec. 17, T. 162 N., R. 77 W.

Ap—0 to 6 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine and fine roots; neutral; abrupt smooth boundary.

B21—6 to 11 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; neutral; clear wavy boundary.

B22—11 to 22 inches; dark grayish brown (10YR 4/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; slightly hard,

very friable, slightly sticky and slightly plastic; few very fine roots; neutral; gradual wavy boundary.

B3—22 to 32 inches; dark brown (10YR 4/3) fine sandy loam, pale brown (10YR 6/3) dry; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; neutral; gradual wavy boundary.

C1ca—32 to 40 inches; grayish brown (2.5Y 5/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; massive; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; common medium irregularly shaped masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C2—40 to 60 inches; grayish brown (2.5Y 5/2) stratified fine sandy loam and loam, light brownish gray (2.5Y 6/2) dry; massive; slightly hard, very friable, slightly sticky and slightly plastic; few medium irregularly shaped masses of lime; mildly alkaline; strong effervescence.

The mollic epipedon is 8 to 16 inches thick. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The B2 horizon has hue of 10YR or 2.5Y, value of 3 or 4 (4 or 5 dry), and chroma of 2 to 4. The C horizon has hue of 2.5Y or 10YR, value of 4 or 5 (5 to 7 dry), and chroma of 2 to 4.

Embden series

The Embden series consists of deep, moderately well drained, moderately rapidly permeable soils on outwash plains. The soils formed in glacial outwash. Slope ranges from 0 to 3 percent.

Embden soils are similar to Egeland and Swenoda soils and commonly are adjacent to Eckman, Egeland, Gardena, Hecla, and Swenoda soils. Swenoda soils contain more clay at a depth of 22 to 40 inches than Embden soils. Hecla soils contain more sand throughout than Embden soils. Gardena and Eckman soils contain more silt and less sand than Embden soils. Egeland soils have a mollic epipedon that is less than 16 inches thick. They are in slightly higher positions.

Typical pedon of Embden fine sandy loam, 0 to 3 percent slopes, in a cultivated field, 2,640 feet west and 90 feet north of the southeast corner of sec. 21, T. 159 N., R. 75 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; neutral; abrupt smooth boundary.

A12—8 to 14 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; neutral; clear wavy boundary.

B2—14 to 21 inches; very dark brown (10YR 2/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; neutral; clear wavy boundary.

B3ca—21 to 28 inches; very dark grayish brown (2.5Y 3/2) fine sandy loam, grayish brown (2.5Y 5/2) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine irregularly shaped soft masses of lime; strong effervescence; mildly alkaline; gradual wavy boundary.

C1ca—28 to 48 inches; grayish brown (2.5Y 5/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; massive; soft, very friable, nonsticky and nonplastic; few fine irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—48 to 60 inches; grayish brown (2.5Y 5/2) fine sandy loam, pale yellow (2.5Y 7/4) dry; common medium distinct yellowish brown (10YR 5/6) and gray (5Y 6/1) mottles; massive; soft, very friable, nonsticky and nonplastic; strong effervescence; moderately alkaline.

The mollic epipedon is 16 to more than 30 inches thick. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The B horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. In some pedons the B3 horizon is mottled. The Cca horizon has hue of 2.5Y, value of 4 to 6 (6 to 8 dry), and chroma of 2 to 4. The C horizon has hue of 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4.

Eramosh series

The Eramosh series consists of deep, very poorly drained soils that formed in silty sediment overlain by organic material. Permeability is moderate. The soils are in depressions on wooded till plains. Slope is 0 to 1 percent.

Eramosh soils are similar to Parnell soils and commonly are adjacent to Bottineau and Kelvin soils. Unlike Eramosh soils, Parnell soils do not have lime in the upper part of the profile, nor do they have a histic epipedon. Bottineau and Kelvin soils are well drained and surround depressions on uplands.

Typical pedon of Eramosh peat, in a depression, 2,800 feet east and 1,900 feet south of the northwest corner of sec. 36, T. 164 N., R. 76 W.

Oi—8 to 4 inches; very dark brown (10YR 2/2) peat, very dark gray (10YR 3/1) dry; hemic material; 60 percent fiber, 30 percent rubbed; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many medium, fine, and very fine roots; neutral; clear smooth boundary.

Oe—4 inches to 0; black (10YR 2/1) muck, very dark brown (10YR 2/2) dry; hemic material; 15 percent fiber, 2 percent rubbed; weak fine and medium granular structure; soft, very friable, nonsticky and nonplastic; many fine and very fine roots; neutral; clear wavy boundary.

A1—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; soft, friable, nonsticky and nonplastic; common fine and few medium roots; common dark reddish brown (5YR 3/4) stains on vertical faces of peds; slight effervescence; mildly alkaline; clear wavy boundary.

C1—8 to 17 inches; grayish brown (2.5Y 5/2) silt loam, light gray (5Y 7/1) dry; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; common dark reddish brown (5YR 3/3) stains on vertical faces of peds; slight effervescence; moderately alkaline; gradual wavy boundary.

C2—17 to 45 inches; very dark grayish brown (2.5Y 3/2) silt loam, gray (5Y 6/1) dry; weak coarse prismatic structure parting to weak coarse subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; common dark reddish brown (2.5YR 3/4) stains on faces of peds; 10 percent snail shells; strong effervescence; mildly alkaline; gradual wavy boundary.

C3—45 to 60 inches; gray (5Y 5/1) silt loam, gray (5Y 6/1) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; 10 percent snail shells; strong effervescence; mildly alkaline.

The histic epipedon is 8 to 16 inches thick. The O horizon has hue of 10YR, value of 2 (2 or 3 dry), and chroma of 1 or 2. The A horizon has hue of 10YR, value of 3 or 4 (5 or 6 dry), and chroma of 1 or 2. The underlying material has hue of 2.5Y or 5Y, value of 3 to 5 (5 to 7 dry), and chroma of 1 or 2.

Exline series

The Exline series consists of deep, somewhat poorly drained, very slowly permeable soils on glacial lacustrine plains. The soils formed in calcareous lacustrine deposits. Slope is 0 to 1 percent.

Exline soils commonly are adjacent to Aberdeen soils. Unlike Exline soils, Aberdeen soils do not have columnar structure in the B2t horizon and do not have salt and gypsum crystals within a depth of 16 inches. They are in slightly higher positions.

Typical pedon of Exline silt loam, in an area of Aberdeen-Exline silt loams, in a pasture, 10 feet north and 1,800 feet west of the southeast corner of sec. 33, T. 162 N., R. 75 W.

A2—0 to 3 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; moderate medium platy structure; hard, friable, slightly sticky and slightly plastic; many fine and medium roots; slightly acid; abrupt smooth boundary.

B2t—3 to 8 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; strong medium columnar structure parting to moderate fine and medium angular blocky; very hard, very firm, very sticky and very plastic; many fine and medium roots on faces of peds and few fine roots inside columns; gray (10YR 5/1) sand grain coatings on top of peds; moderately alkaline; clear wavy boundary.

B3casa—8 to 12 inches; dark grayish brown (2.5Y 4/2) and very dark grayish brown (2.5Y 3/2) silty clay loam, grayish brown (2.5Y 5/2) and dark grayish brown (2.5Y 4/2) dry; moderate medium subangular blocky structure; hard, firm, very sticky and very plastic; common fine roots; many fine filaments of salt crystals; few fine irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C1ca—12 to 23 inches; light olive brown (2.5Y 5/4) silty clay loam, light brownish gray (2.5Y 6/2) dry; massive; hard, firm, sticky and plastic; few fine roots; few fine filaments of salt crystals; few fine irregularly shaped soft masses of lime; violent effervescence; strongly alkaline; gradual wavy boundary.

C2ca—23 to 39 inches; olive brown (2.5Y 4/4) silty clay loam, light olive brown (2.5Y 5/4) dry; many medium distinct yellowish brown (10YR 5/4) mottles; massive; hard, firm, sticky and plastic; few very fine roots; common medium rounded nests of gypsum crystals; few fine irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C3—39 to 60 inches; very dark grayish brown (2.5Y 3/2) silty clay, grayish brown (2.5Y 5/2) dry; many medium distinct olive brown (2.5Y 4/4) mottles; massive; extremely hard, extremely firm, sticky and very plastic; many large irregularly shaped nests of gypsum crystals; strong effervescence; moderately alkaline.

In some pedons there is a thin A1 horizon. The A2 horizon has hue of 10YR, value of 3 to 5 (5 or 6 dry), and chroma of 1. The B2t horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 or 2. It is silty clay loam or silty clay. The C horizon has hue of 2.5Y or 5Y, value of 3 to 7 (5 to 8 dry), and chroma of 2 to 4.

Fargo series

The Fargo series consists of deep, poorly drained, slowly permeable soils on glacial lacustrine plains. The soils formed in silty clay or clay lacustrine sediment. Slope is 0 to 1 percent.

Fargo soils are similar to Hegne soils and commonly are adjacent to Hegne and Overly soils. Unlike Fargo soils, Hegne soils have a calcic horizon within a depth of 16 inches. They are in slightly higher positions. Overly soils are moderately well drained and contain less clay than Fargo soils. They are in slightly higher positions.

Typical pedon of Fargo silty clay, in a cultivated field, 2,380 feet north and 1,175 feet west of the southeast corner of sec. 10, T. 160 N., R. 76 W.

Ap—0 to 5 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; moderate fine and medium granular structure; very hard, very firm, very sticky and very plastic; many fine and medium roots; neutral; abrupt smooth boundary.

B21—5 to 12 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; strong fine and very fine angular blocky structure; extremely hard, extremely firm, very sticky and very plastic; common fine and very fine roots; cracks filled with material from the A horizon extend throughout; mildly alkaline; gradual irregular boundary.

B22—12 to 21 inches; black (10YR 2/1) and dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) and dark gray (10YR 4/1) dry; strong fine and very fine angular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few very fine roots; cracks filled with material from the A horizon extend throughout; common medium irregularly shaped soft masses of lime; strong effervescence; mildly alkaline; gradual irregular boundary.

C1gca—21 to 41 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; weak medium subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few very fine roots; few fine irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C2gcs—41 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay, olive gray (5Y 5/2) dry; massive; extremely hard, extremely firm, very sticky and very plastic; many large irregularly shaped masses of gypsum crystals; strong effervescence; moderately alkaline.

The mollic epipedon is 8 to 24 inches thick. The solum is 16 to 36 inches thick. The A horizon has hue of 10YR or 2.5Y, value of 1 or 2 (3 or 4 dry), and chroma of 1. The B2 horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 or 2. The Cg horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 8 dry), and chroma of 1 to 3.

Gardena series

The Gardena series consists of deep, moderately well drained, moderately permeable soils on glacial lacustrine plains. The soils formed in silty, calcareous lacustrine material. Slope ranges from 0 to 3 percent.

Gardena soils are similar to Eckman and Overly soils and commonly are adjacent to Eckman, Embden, Glyndon, and Overly soils. Overly soils contain more clay than Gardena soils. Unlike Gardena soils, Eckman soils have a mollic epipedon that is less than 16 inches thick. They are in slightly higher positions. Glyndon soils do not have a B horizon and have a calcic horizon within a depth of 16 inches. They are in lower lying positions. Embden soils contain more sand than Gardena soils.

Typical pedon of Gardena silt loam, 0 to 3 percent slopes, in a cultivated field (summer fallow), 700 feet west and 375 feet north of the southeast corner of sec. 36, T. 159 N., R. 74 W.

Ap—0 to 9 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; moderate medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; mildly alkaline; abrupt smooth boundary.

B2—9 to 17 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak medium prismatic structure parting to moderate coarse and medium angular blocky; slightly hard, very friable, slightly sticky and slightly plastic; thin clay films on vertical faces; mildly alkaline; clear wavy boundary.

B3ca—17 to 24 inches; very dark grayish brown (2.5Y 3/2) silt loam, dark grayish brown (2.5Y 4/2) dry; weak coarse and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

C1ca—24 to 30 inches; grayish brown (2.5Y 5/2) and light brownish gray (2.5Y 6/2) silt loam, light brownish gray (2.5Y 6/2) and light gray (2.5Y 7/2) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C2—30 to 50 inches; grayish brown (2.5Y 5/2) silt loam, light brownish gray (2.5Y 6/2) dry; massive; hard, friable, sticky and plastic; strong effervescence; moderately alkaline; gradual wavy boundary.

C3—50 to 60 inches; dark grayish brown (2.5Y 4/2) and grayish brown (2.5Y 5/2) and light brownish gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) and light brownish gray (2.5Y 6/2) and light gray (2.5Y 7/2) dry; massive; very hard, firm, sticky and plastic; strong effervescence; moderately alkaline.

The solum and the mollic epipedon are 16 to 30 inches thick. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The B2 horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. The Cca horizon has hue of 10YR or

2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. In some pedons the lower part of the C horizon below a depth of 40 inches is sand, silt, clay, loam, or clay loam.

Glyndon series

The Glyndon series consists of deep, somewhat poorly drained, moderately permeable soils on glacial lacustrine plains. The soils formed in calcareous lacustrine material. Slope is 0 to 1 percent.

Glyndon soils are similar to Bearden and Wyndmere soils and commonly are adjacent to Gardena and Wyndmere soils. Bearden soils contain more clay than Glyndon soils. Wyndmere soils contain more sand than Glyndon soils. Gardena soils have a mollic epipedon that is more than 16 inches thick, and they are in slightly higher positions.

Typical pedon of Glyndon silt loam, in a cultivated field, 1,775 feet west and 180 feet south of the northeast corner of sec. 33, T. 159 N., R. 75 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure parting to moderate medium granular; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and fine roots; strong effervescence; moderately alkaline; abrupt smooth boundary.

C1ca—8 to 13 inches; grayish brown (2.5Y 5/2) silt loam, light brownish gray (2.5Y 6/2) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and fine roots; many fine irregularly shaped soft masses of lime; violent effervescence; strongly alkaline; clear wavy boundary.

C2ca—13 to 28 inches; light olive brown (2.5Y 5/4) very fine sandy loam, light yellowish brown (2.5Y 6/4) dry; weak coarse and medium subangular blocky structure; soft, very friable, nonsticky and slightly plastic; many very fine and fine roots; common fine irregularly shaped soft masses of lime; violent effervescence; strongly alkaline; gradual wavy boundary.

C3—28 to 48 inches; light olive brown (2.5Y 5/4) very fine sandy loam, light yellowish brown (2.5Y 6/4) dry; common medium distinct gray (5Y 6/1) and dark brown (7.5YR 4/4) mottles; massive; soft, very friable, nonsticky and slightly plastic; strong effervescence; moderately alkaline; gradual wavy boundary.

C4—48 to 60 inches; light olive brown (2.5Y 5/4) silt loam, light yellowish brown (2.5Y 6/4) dry; many large prominent gray (5Y 6/1) and dark brown (7.5YR 4/4) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 16 inches thick. The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1. The Cca horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 to 4. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6 (5 to 7 dry), and chroma of 2 to 4.

Great Bend series

The Great Bend series consists of deep, well drained, moderately slowly permeable soils on glacial lacustrine plains. The soils formed in calcareous, silty lacustrine material. Slope ranges from 0 to 3 percent.

Great Bend soils are similar to Eckman and Overly soils and commonly are adjacent to Overly soils. Eckman soils contain less clay than Great Bend soils. Overly soils have a mollic epipedon that is more than 16 inches thick. They are in swales.

Typical pedon of Great Bend silty clay loam, in an area of Overly-Great Bend silty clay loams, 0 to 3 percent slopes, in a cultivated field, 65 feet north and 1,700 feet east of the southwest corner of sec. 19, T. 161 N., R. 75 W.

Ap—0 to 6 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; slightly hard, very friable, sticky and plastic; common fine and very fine roots; neutral; abrupt smooth boundary.

B2—6 to 14 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to moderate medium angular blocky; slightly hard, friable, sticky and plastic; common fine and very fine roots; many thin clay films on faces of peds; mildly alkaline; clear wavy boundary.

C1ca—14 to 28 inches; light yellowish brown (2.5Y 6/4) silty clay loam, pale yellow (2.5Y 7/4) dry; massive; slightly hard, friable, sticky and plastic; few very fine roots; common fine filaments and soft masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C2—28 to 60 inches; light olive brown (2.5Y 5/4) silty clay loam, light yellowish brown (2.5Y 6/4) dry; massive; slightly hard, friable, sticky and plastic; common large irregularly shaped soft masses of gypsum crystals; strong effervescence; moderately alkaline.

The mollic epipedon is 6 to 16 inches thick. The solum is 12 to 20 inches thick. The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1. The B horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 4. It is silty clay loam or silt loam. The C horizon has hue of 2.5Y, value of 4 to 6 (6 to 8 dry), and chroma of 2 to 4. It is silty clay loam or silt loam.

Hamerly series

The Hamerly series consists of deep, somewhat poorly drained, moderately slowly permeable soils on till plains. The soils commonly surround and are between shallow depressions. Slope ranges from 0 to 3 percent.

Hamerly soils are similar to Bearden soils and commonly are adjacent to Barnes, Svea, Tonka, and Vallers soils. Bearden soils contain more silt and less sand than Hamerly soils. Vallers soils are poorly drained. They are in lower lying positions than Hamerly soils. Tonka soils are poorly drained and are in shallow depressions. Barnes soils are well drained, and Svea soils are moderately well drained. Unlike Hamerly soils, Barnes and Svea soils have a B2 horizon. They are in higher positions.

Typical pedon of Hamerly loam, in an area of Hamerly-Tonka complex, 0 to 3 percent slopes, in a cultivated field, 275 feet west and 1,055 feet north of the southeast corner of sec. 25, T. 159 N., R. 83 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to moderate medium granular; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

C1ca—7 to 13 inches; light olive brown (2.5Y 5/4) and light brownish gray (2.5Y 6/2) loam, light brownish gray (2.5Y 6/2) and light gray (2.5Y 7/2) dry; few fine faint dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common fine irregularly shaped soft masses of lime; about 10 percent coarse fragments; violent effervescence; moderately alkaline; gradual wavy boundary.

C2ca—13 to 34 inches; olive (5Y 5/3) loam, light brownish gray (2.5Y 6/2) dry; few fine distinct strong brown (7.5YR 5/8) and common fine distinct gray (N 5/0) mottles; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine irregularly shaped soft masses of lime; about 10 percent coarse fragments; violent effervescence; moderately alkaline; gradual wavy boundary.

C3—34 to 60 inches; light olive brown (2.5Y 5/4) clay loam, light brownish gray (2.5Y 6/2) dry; common medium distinct gray (N 5/0) and many medium prominent strong brown (7.5YR 5/8) mottles; massive; hard, firm, sticky and plastic; many large nests of gypsum crystals; about 10 percent coarse fragments; slight effervescence; moderately alkaline.

The mollic epipedon is 7 to 16 inches thick. The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6 (5 to 8 dry), and chroma of 1 to 4. It is loam or clay loam.

Hecla series

The Hecla series consists of deep, moderately well drained, rapidly permeable soils on lacustrine and glacial outwash plains. These soils formed in sandy glacial outwash deposits. Slope ranges from 0 to 6 percent.

Hecla soils are similar to Maddock and Towner soils and are commonly adjacent to Embden, Maddock, Serden, and Ulen soils. Unlike Hecla soils, Towner soils have a lower substratum that is loam. Maddock soils are well drained. They are in higher positions than Hecla soils. Embden soils contain more silt and clay than Hecla soils. Ulen soils have a calcic horizon within a depth of 16 inches. They are in lower lying positions. Serden soils do not have a mollic epipedon, are excessively drained, and are in higher positions.

Typical pedon of Hecla loamy fine sand, 0 to 3 percent slopes, in a cultivated field, 800 feet east and 600 feet south of the northwest corner of sec. 28, T. 159 N., R. 74 W.

Ap—0 to 14 inches; black (10YR 2/1) loamy fine sand, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to weak medium granular; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; slightly acid; clear wavy boundary.

A12—14 to 21 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to weak medium granular; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; mildly alkaline; gradual wavy boundary.

C1—21 to 39 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; loose, nonsticky and nonplastic; few very fine roots; mildly alkaline; gradual wavy boundary.

C2—39 to 48 inches; dark grayish brown (10YR 4/2) fine sand, light yellowish brown (10YR 6/4) dry; common medium distinct dark yellowish brown (10YR 4/4) mottles; single grain; loose, nonsticky and nonplastic; mildly alkaline; gradual wavy boundary.

C3—48 to 60 inches; dark grayish brown (10YR 4/2) fine sand, pale brown (10YR 6/3) dry; single grain; loose, nonsticky and nonplastic; strong effervescence; moderately alkaline.

The solum is 16 to 30 inches thick. The mollic epipedon is 10 to 20 inches thick. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. It is loamy fine sand, loamy sand, or fine sand. In some pedons there is an AC horizon. The C horizon has hue of 10YR, 5Y, or 2.5Y, value of 3 to 5 (4 to 7 dry), and chroma of 2 to 4. It is loamy fine sand, loamy sand,

or fine sand. Mottles are at a depth between 20 and 40 inches.

Hegne series

The Hegne series consists of deep, poorly drained, very slowly permeable soils on glacial lacustrine plains. The soils formed in clayey lacustrine sediment. Slope is 0 to 1 percent.

Hegne soils are similar to Fargo soils and commonly are adjacent to Fargo and Overly soils. Fargo soils are in lower lying positions than Hegne soils. Fargo and Overly soils do not have a calcic horizon within a depth of 16 inches. In addition, Overly soils are moderately well drained and contain less clay than Hegne soils.

Typical pedon of Hegne silty clay, in a cultivated field, 120 feet east and 2,440 feet north of the southwest corner of sec. 18, T. 162 N., R. 77 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) silty clay, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure parting to moderate medium granular; hard, firm, sticky and very plastic; few fine roots; strong effervescence; moderately alkaline; abrupt smooth boundary.

C1ca—7 to 16 inches; dark gray (5Y 4/1) silty clay, gray (5Y 5/1) dry; weak medium subangular blocky structure; very hard, firm, sticky and very plastic; few fine roots; very dark gray (10YR 3/1) coatings of material from the A horizon in the cracks between peds; few fine irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C2ca—16 to 43 inches; dark gray (5Y 4/1) silty clay, olive gray (5Y 5/2) dry; weak very fine angular blocky structure; very hard, very firm, sticky and very plastic; few fine roots; few fine irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C3—43 to 60 inches; olive gray (5Y 4/2) silty clay, olive gray (5Y 5/2) dry; common medium distinct strong brown (7.5YR 5/6) mottles; massive; very hard, very firm, very sticky and very plastic; many large irregularly shaped nests of gypsum crystals; stratified; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 16 inches thick. The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 or 4 dry), and chroma of 1. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (4 to 7 dry), and chroma of 1 or 2. It is silty clay or clay. It has mottles in some or all parts. In some places, tongues of the A horizon extend to a depth of 36 inches.

Kelvin series

The Kelvin series consists of deep, well drained, moderately slowly permeable soils on glaciated uplands. The soils formed in calcareous till. Slope ranges from 3 to 25 percent.

Kelvin soils are similar to Bottineau soils and commonly are adjacent to Bottineau, Eramosh, Metigoshe, and Rolla soils. Unlike Kelvin soils, Bottineau soils do not have an A2 horizon and do have a mollic epipedon. Eramosh soils have a histic epipedon and are very poorly drained. They are in depressions. Metigoshe soils have sand and gravel at a depth of 10 to 18 inches. Rolla soils contain more clay than Kelvin soils, and they formed in lacustrine sediment. They are on lacustrine plains.

Typical pedon of Kelvin loam, 9 to 25 percent slopes, in a woodland, located 500 feet north and 1,000 feet west of the southeast corner of sec. 36, T. 164 N., R. 76 W.

O1—2 inches to 0; black (10YR 2/1) undecomposed leaves and twigs; neutral; abrupt smooth boundary.

A2—0 to 5 inches; very dark grayish brown (10YR 3/2) loam, light brownish gray (10YR 6/2) dry; weak fine platy structure parting to moderate fine subangular blocky; slightly hard, firm, slightly sticky and slightly plastic; many medium fine and very fine roots; about 5 percent coarse fragments; neutral; abrupt smooth boundary.

B&A—5 to 8 inches; very dark grayish brown (10YR 3/2) clay loam, brown (10YR 5/3) dry (B2t); dark brown (10YR 4/3) loam, light brownish gray (10YR 6/2) dry (A2); strong fine angular blocky structure; very hard, firm, sticky and plastic; common fine and very fine roots; continuous thin clay films on faces of peds; about 5 percent coarse fragments; neutral; clear smooth boundary.

B21t—8 to 15 inches; very dark grayish brown (10YR 3/2) clay, dark grayish brown (10YR 4/2) crushed, brown (10YR 5/3) dry; moderate coarse and strong medium prismatic structure parting to strong fine and medium angular blocky; very hard, firm, sticky and plastic; few fine and medium roots; continuous thick clay films on faces of peds and lining pores; about 5 percent coarse fragments; neutral; clear smooth boundary.

B22t—15 to 27 inches; very dark grayish brown (10YR 3/2) clay loam, dark brown (10YR 3/3) crushed, grayish brown (10YR 5/2) dry; few medium distinct dark yellowish brown (10YR 4/4) mottles; moderate medium and coarse prismatic structure parting to strong fine and medium angular blocky; very hard, very firm, sticky and plastic; few fine roots; continuous thick clay films on faces of peds and lining pores; about 5 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

B3t—27 to 41 inches; dark brown (10YR 3/3) clay loam, grayish brown (10YR 5/2) dry; common fine distinct dark yellowish brown (10YR 3/4) and few fine

distinct dark brown (7.5YR 4/4) mottles; moderate coarse prismatic structure parting to moderate medium angular blocky; very hard, very firm, sticky and plastic; few fine roots; many moderately thick clay films on faces of peds; few fine lime coatings in root channels on faces of peds; about 5 percent coarse fragments; slight effervescence; mildly alkaline; gradual smooth boundary.

C—41 to 60 inches; light brownish gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) crushed, light brownish gray (10YR 6/2) dry; few fine distinct dark brown (7.5YR 4/4) mottles; weak very coarse prismatic structure; very hard, firm, sticky and plastic; few fine roots; few fine lime coatings in root channels on faces of peds; about 5 percent coarse fragments; strong effervescence; moderately alkaline.

The solum is 22 to 44 inches thick. Depth to carbonates ranges from 13 to 44 inches. The A2 horizon has hue of 10YR, value of 3 or 4 (6 or 7 dry), and chroma of 1 or 2. In some pedons there is an A1 horizon. The B2t horizon has hue of 10YR or 2.5Y, value of 3 or 4 (5 or 6 dry), and chroma of 2 to 4. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 moist or dry, and chroma of 2 to 4. It is loam or clay loam.

Letcher series

The Letcher series consists of deep, moderately well drained, slowly permeable soils on outwash plains. The soils formed in glacial outwash sediment. Slope ranges from 0 to 3 percent.

Letcher soils commonly are adjacent to Embden, Hecla, and Stirum soils. Unlike Letcher soils, Embden and Hecla soils do not have a natric horizon. Embden soils are in higher positions than Letcher soils. Stirum soils are poorly drained and are in slight depressions.

Typical pedon of Letcher fine sandy loam, 0 to 3 percent slopes, in a cultivated field, 2,100 feet north and 375 feet west of the southeast corner of sec. 28, T. 159 N., R. 74 W.

Ap—0 to 6 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure parting to weak fine granular; slightly hard, very friable, nonsticky and nonplastic; mildly alkaline; clear smooth boundary.

A2—6 to 9 inches; very dark gray (10YR 3/1) fine sandy loam, light gray (10YR 6/1) dry; weak medium platy structure; slightly hard, very friable, nonsticky and nonplastic; mildly alkaline; clear wavy boundary.

B2t—9 to 16 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; strong very coarse columnar structure; extremely hard, very firm, nonsticky and nonplastic; continuous thin clay films on faces of peds; grayish brown (10YR 5/2) coatings on top of columns; strongly alkaline; clear smooth boundary.

B3ca—16 to 28 inches; dark grayish brown (10YR 4/2) sandy loam, brown (10YR 5/3) dry; few medium distinct dark yellowish brown (10YR 4/4) mottles; moderate very coarse prismatic structure; hard, friable, nonsticky and nonplastic; few fine filaments of lime; slight effervescence; very strongly alkaline; clear smooth boundary.

C1ca—28 to 33 inches; grayish brown (2.5Y 5/2) sandy loam, light brownish gray (2.5Y 6/2) dry; common medium distinct light olive brown (2.5Y 5/4) mottles; massive; hard, friable, nonsticky and nonplastic; few fine filaments of lime; strong effervescence; very strongly alkaline; abrupt smooth boundary.

C2ca—33 to 37 inches; light olive brown (2.5Y 5/4) fine sandy loam, grayish brown (2.5Y 5/2) dry; many medium distinct yellowish brown (10YR 5/6) mottles; massive; slightly hard, friable, nonsticky and nonplastic; common fine irregularly shaped soft masses of lime; strong effervescence; very strongly alkaline; clear smooth boundary.

C3—37 to 60 inches; light olive brown (2.5Y 5/4) loamy fine sand, light yellowish brown (2.5Y 6/4) dry; many medium distinct yellowish brown (10YR 5/6) and few medium distinct light yellowish brown (2.5Y 6/4) mottles; massive; slightly hard, friable, nonsticky and nonplastic; slight effervescence; very strongly alkaline.

The A horizon has hue of 10YR, value of 2 or 3 (4 or 5 dry), and chroma of 1. The A2 horizon has hue of 10YR, value of 3 to 5 (6 or 7 dry), and chroma of 1 or 2. The B2 horizon has hue of 10YR or 2.5Y, value of 3 or 4 (4 or 5 dry), and chroma of 2 or 3. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 5 (5 or 6 dry), and chroma of 1 to 4.

Maddock series

The Maddock series consists of deep, well drained, rapidly permeable soils on sandy lacustrine and glacial outwash plains. The soils formed in outwash and lacustrine deposits. Slope ranges from 3 to 6 percent.

Maddock soils are similar to Hecla soils and commonly are adjacent to Embden, Hecla, and Serden soils. Hecla soils are moderately well drained and are in lower lying positions than Maddock soils. Embden soils contain more silt and clay than Maddock soils. Serden soils do not have a mollic epipedon. They are in higher positions.

Typical pedon of Maddock loamy fine sand, 3 to 6 percent slopes, in a cultivated field, 1,750 feet south and 950 feet east of the northwest corner of sec. 27, T. 159 N., R. 74 W.

Ap—0 to 6 inches; black (10YR 2/1) loamy fine sand, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard, very

friable, nonsticky and nonplastic; common fine roots; mildly alkaline; abrupt smooth boundary.

A12—6 to 14 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few fine roots; mildly alkaline; gradual wavy boundary.

B2—14 to 30 inches; dark grayish brown (10YR 4/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; slightly hard, very friable, nonsticky and nonplastic; few fine roots; neutral; gradual wavy boundary.

C1—30 to 38 inches; olive brown (2.5Y 4/4) loamy fine sand, light yellowish brown (2.5Y 6/4) dry; massive; slightly hard, very friable, nonsticky and nonplastic; few fine roots; strong effervescence; mildly alkaline; gradual wavy boundary.

C2—38 to 60 inches; grayish brown (2.5Y 5/2) loamy fine sand, light brownish gray (2.5Y 6/2) dry; massive; slightly hard, very friable, nonsticky and nonplastic; strong effervescence; moderately alkaline.

The mollic epipedon is 10 to 16 inches thick. The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1. The B horizon has hue of 10YR, value of 2 to 5 (4 to 6 dry), and chroma of 2 to 4. It is loamy fine sand, loamy sand, or fine sand. The C horizon has hue of 10YR or 2.5Y, value of 3 to 6 (4 to 7 dry), and chroma of 2 to 4. It is loamy fine sand, loamy sand, or fine sand.

Marysland series

The Marysland series consists of deep, poorly drained, moderately permeable over rapidly permeable soils on glacial outwash plains and in drainageways. The soils formed in loamy material underlain by gravelly sand. Slope is 0 to 1 percent.

Marysland soils are similar to Arveson, Divide, and Vallers soils and commonly are adjacent to Divide soils. Arveson soils contain more sand and less gravel in the lower part of the profile than Marysland soils. Divide soils are somewhat poorly drained. They are in slightly higher positions. Vallers soils have a loam substratum.

Typical pedon of Marysland loam, in a pasture, 1,500 feet north and 1,575 feet west of the southeast corner of sec. 36, T. 162 N., R. 74 W.

A11—0 to 5 inches; black (10YR 2/1) loam, very dark gray (N 3/0) dry; moderate medium granular structure; soft, very friable, slightly sticky and slightly plastic; many fine roots; slight effervescence; moderately alkaline; clear wavy boundary.

A12ca—5 to 19 inches; very dark gray (10YR 3/1) loam, dark gray (N 4/0) and gray (N 5/0) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; about 5 percent coarse fragments; few fine soft masses of lime; violent effervescence; moderately alkaline; abrupt wavy boundary.

C1ca—19 to 23 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; common medium distinct light yellowish brown (2.5Y 6/4, dry) mottles; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; common fine soft masses of lime; about 5 percent coarse fragments; violent effervescence; moderately alkaline; gradual wavy boundary.

C2ca—23 to 27 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; common medium light yellowish brown (2.5Y 6/4, dry) mottles; massive; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; common fine soft masses of lime; about 10 percent coarse fragments; violent effervescence; moderately alkaline; gradual wavy boundary.

IIC3—27 to 35 inches; light brownish gray (2.5Y 6/2) gravelly sand, light gray (2.5Y 7/2) dry; common medium light yellowish brown (2.5Y 6/4, dry) mottles; single grain; loose, nonsticky and nonplastic; about 20 percent gravel; strong effervescence; moderately alkaline; gradual wavy boundary.

IIC4—35 to 60 inches; yellowish brown (10YR 5/6) gravelly sand, light yellowish brown (2.5Y 6/4) dry; single grain; loose, nonsticky and nonplastic; about 20 percent gravel; strong effervescence; moderately alkaline.

Depth to the IIC horizon ranges from 20 to 40 inches. The A horizon has hue of 2.5Y or 10YR, value of 2 or 3, and chroma of 1. It has hue of N and value of 3 to 5 dry. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 or 2. The IIC horizon is sand or gravelly sand.

Metigoshe series

The Metigoshe series consists of deep, well drained, moderately permeable over very rapidly permeable soils in areas of sandy and gravelly outwash. These soils formed in loamy alluvium underlain by sand and gravel at a depth of 10 to 18 inches. Slope ranges from 3 to 25 percent.

Metigoshe soils are commonly adjacent to Bottineau and Kelvin soils. Unlike Metigoshe soils, Bottineau and Kelvin soils do not have a gravelly IIC horizon.

Typical pedon of Metigoshe coarse sandy loam, 9 to 25 percent slopes, in a woodland, 2,450 feet west and 1,800 feet north of the southeast corner of sec. 27, T. 164 N., R. 75 W.

O1—2 inches to 0; black (10YR 2/1) undecomposed leaves and twigs; neutral; abrupt smooth boundary.
A1—0 to 5 inches; black (10YR 2/1) coarse sandy loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; soft, friable, nonsticky and slightly plastic; common fine roots; slightly acid; clear wavy boundary.
A2—5 to 8 inches; very dark grayish brown (10YR 3/2) loamy coarse sand, pale brown (10YR 6/3) dry; weak medium subangular blocky structure parting to weak medium granular; soft, very friable, nonsticky and nonplastic; common fine and very fine roots; slightly acid; clear wavy boundary.
B2t—8 to 11 inches; very dark grayish brown (10YR 3/2) coarse sandy loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; common very fine and fine roots; interfingering of pale brown (10YR 6/3, dry) material from the A2 horizon throughout; common thin clay films on faces of peds; mildly alkaline; gradual wavy boundary.
IIC1—11 to 17 inches; dark grayish brown (10YR 4/2) gravelly loamy coarse sand, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; soft, friable, nonsticky and nonplastic; few fine roots; about 25 percent gravel; slight effervescence; mildly alkaline; gradual wavy boundary.
IIC2—17 to 60 inches; grayish brown (10YR 5/2) gravelly coarse sand, light brownish gray (10YR 6/2) dry; single grain; loose, nonsticky and nonplastic; about 30 percent gravel; strong effervescence; mildly alkaline.

The solum is 10 to 18 inches thick. Depth to loose sand and gravel ranges from 10 to 18 inches. The A1 horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. In some places there is an Ap horizon that is sandy loam or loam and has chroma of 1 or 2 dry. The A2 horizon has hue of 10YR, value of 3 or 4 (4 to 7 dry), and chroma of 2 to 4. It is coarse sandy loam or loamy coarse sand. The B2t horizon has hue of 10YR, value of 3 or 4 (4 to 6 dry), and chroma of 2 to 4. It is coarse sandy loam or sandy loam. The IIC horizon has hue of 10YR or 2.5Y, value of 3 to 6 (5 to 8 dry), and chroma of 2 to 6. It is coarse sand, gravelly coarse sand, or gravelly loamy coarse sand.

Overly series

The Overly series consists of deep, moderately well drained, moderately slowly permeable soils on glacial lacustrine plains. The soils formed in calcareous, silty lacustrine material. Slope is 0 to 1 percent.

Overly soils are similar to Gardena and Great Bend soils and commonly are adjacent to Bearden, Colvin, Fargo, Gardena, Glyndon, Great Bend, and Hegne soils. Gardena and Glyndon soils contain less clay than Overly soils. Bearden and Glyndon soils have a calcic horizon within a depth of 16 inches. They are in lower lying positions than Overly soils. Great Bend soils have a mollic epipedon that is less than 16 inches thick. They are in higher positions. Fargo and Hegne soils are poorly drained and contain more clay than Overly soils. Colvin soils are poorly drained and have a calcic horizon within a depth of 16 inches. They are in lower lying positions.

Typical pedon of Overly silty clay loam, in an area of Overly-Great Bend silty clay loams, 0 to 3 percent slopes, in a cultivated field, 200 feet north and 350 feet west of the southeast corner of sec. 13, T. 162 N., R. 78 W.

Ap—0 to 7 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; hard, friable, sticky and very plastic; common fine and very fine roots; neutral; abrupt smooth boundary.
A12—7 to 17 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; strong medium subangular blocky structure; very hard, friable, very sticky and very plastic; common fine and very fine roots; few thin clay films on faces of peds; mildly alkaline; gradual wavy boundary.
B2—17 to 27 inches; dark brown (10YR 3/3) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine prismatic structure parting to moderate medium angular blocky; very hard, firm, very sticky and very plastic; few very fine roots; common thin clay films on faces of peds; mildly alkaline; gradual wavy boundary.
B3—27 to 30 inches; dark brown (10YR 4/3) silty clay loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; very hard, very firm, very sticky and very plastic; few very fine roots; strong effervescence; mildly alkaline; clear wavy boundary.
C1ca—30 to 39 inches; light olive brown (2.5Y 5/4) silty clay loam, light brownish gray (2.5Y 6/2) dry; weak medium subangular blocky structure; very hard, firm, very sticky and very plastic; many fine soft masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.
C2—39 to 54 inches; olive brown (2.5Y 4/4) silty clay loam, light yellowish brown (2.5Y 6/4) dry; few fine faint yellowish brown (10YR 5/6) and common fine distinct light brownish gray (2.5Y 6/2) mottles; massive; very hard, firm, very sticky and very plastic; strong effervescence; moderately alkaline; gradual wavy boundary.
C3—54 to 60 inches; olive brown (2.5Y 4/4) silty clay, light brownish gray (2.5Y 6/2) dry; common medium distinct very dark grayish brown (2.5Y 3/2) and common fine distinct light brownish gray (2.5Y 6/2) mottles; massive; very hard, very firm, very sticky and very plastic; laminated; few fine soft masses of gypsum; strong effervescence; moderately alkaline.

The mollic epipedon is 16 to 30 inches thick. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. It is silty clay loam or silt loam. The B2 horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. The Cca horizon has hue of 2.5Y, value of 4 to 6 (6 or 7 dry), and chroma of 2 to 4. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (6 or 7 dry), and chroma of 1 to 4.

Parnell series

The Parnell series consists of deep, very poorly drained, slowly permeable soils in depressions and on bottom lands. These soils formed in moderately fine textured and fine textured water-sorted sediment that was washed from glacial drift. Slope is 0 to 1 percent.

Parnell soils are similar to Eramosh soils and commonly are adjacent to Barnes, Hamerly, Svea, Tonka, and Vallers soils. Unlike Parnell soils, Tonka soils have an A2 horizon that is more than 4 inches thick. They are in shallow depressions. Barnes soils are well drained, and Svea soils are moderately well drained. They are in higher lying positions than Parnell soils. Hamerly and Vallers soils have a calcic horizon within a depth of 16 inches. They surround depressions. Eramosh soils do not have an argillic horizon.

Typical pedon of Parnell silty clay loam, in a depression, 105 feet east and 2,050 feet north of the southwest corner of sec. 15, T. 160 N., R. 74 W.

A1—0 to 10 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; common very fine roots; neutral; abrupt smooth boundary.

B21t—10 to 22 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; weak medium prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and very plastic; few very fine roots; common thin clay films on faces of peds; neutral; clear wavy boundary.

B22t—22 to 35 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; strong medium subangular blocky structure; very hard, firm, sticky and very plastic; many thin clay films on faces of peds; mildly alkaline; clear wavy boundary.

B3—35 to 40 inches; very dark gray (5Y 3/1) silty clay, gray (5Y 5/1) dry; weak medium subangular blocky structure; very hard, firm, very sticky and very plastic; slight effervescence; mildly alkaline; gradual wavy boundary.

C1ca—40 to 53 inches; olive gray (5Y 5/2) silty clay, light olive gray (5Y 6/2) dry; many fine prominent strong brown (7.5YR 5/6) mottles; weak very fine angular blocky structure; very hard, extremely firm, sticky and very plastic; few fine irregularly shaped soft masses of lime; violent effervescence; mildly alkaline; gradual wavy boundary.

C2g—53 to 60 inches; olive gray (5Y 5/2) silty clay loam, light gray (5Y 7/2) dry; many large prominent olive yellow (2.5Y 6/6, dry) mottles; massive; hard, firm, slightly sticky and slightly plastic; slight effervescence; mildly alkaline.

The mollic epipedon is 24 to 60 inches thick. The solum is 35 to 60 inches thick. In some places there is an O horizon as much as 6 inches thick. The A horizon has hue of 10YR, value of 2 (3 or 4 dry), and chroma of 1. In some places there is an A2 horizon as much as 4 inches thick. The B horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 or 2. It is silty clay loam, clay loam, silty clay, or clay. The C horizon has hue of 2.5Y or 5Y, value of 3 to 6 (5 to 7 dry), and chroma of 1 or 2.

Rolla series

The Rolla series consists of deep, moderately well drained, slowly permeable soils on glacial lacustrine plains. The soils formed in clay and silty clay lacustrine sediment. Slope ranges from 0 to 6 percent.

Rolla soils commonly are adjacent to Eramosh and Kelvin soils. Eramosh soils are very poorly drained and are in depressions. Kelvin soils contain less clay and more sand than Rolla soils. They are in more sloping positions.

Typical pedon of Rolla silty clay, 0 to 6 percent slopes, in a woodland, 1,290 feet east of the northwest corner of sec. 26, T. 164 N., R. 74 W.

O1—2 inches to 0; black (10YR 2/1) undecomposed leaves, twigs, and roots; few medium and common fine roots; neutral; abrupt smooth boundary.

A1—0 to 2 inches; black (10YR 2/1) silty clay, black (10YR 2/1) dry; strong fine angular blocky structure; slightly hard, friable, sticky and plastic; few medium and common fine roots; slightly acid; abrupt smooth boundary.

A21—2 to 6 inches; dark grayish brown (10YR 4/2) silty clay, gray (10YR 6/1) dry; strong very fine angular blocky structure; extremely hard, extremely firm, sticky and plastic; common fine roots; slightly acid; gradual wavy boundary.

A22—6 to 12 inches; dark grayish brown (10YR 4/2) silty clay, gray (10YR 6/1) dry; strong very fine angular blocky structure; extremely hard, extremely firm, sticky and plastic; common fine roots; few thin clay films on faces of peds and lining pores; slightly acid; gradual wavy boundary.

B21t—12 to 19 inches; dark gray (10YR 4/1) clay, grayish brown (2.5Y 5/2) dry; strong medium angular blocky structure; extremely hard, extremely firm, sticky and very plastic; few fine roots; many moderately thick clay films on faces of peds and lining pores; mildly alkaline; gradual wavy boundary.

B22t—19 to 32 inches; dark grayish brown (2.5Y 4/2) clay, light brownish gray (2.5Y 6/2) dry; strong medium angular blocky structure; extremely hard, extremely firm, sticky and very plastic; few fine roots; many moderately thick clay films on faces of peds and lining pores; strong effervescence; moderately alkaline; gradual wavy boundary.

C—32 to 60 inches; dark grayish brown (2.5Y 4/2) clay, light brownish gray (2.5Y 6/2) and grayish brown (2.5Y 5/2) dry; moderate medium angular blocky structure; very hard, firm, sticky and plastic; few fine roots; common medium soft masses of lime; strong effervescence; moderately alkaline.

The solum is 24 to 40 inches thick. Depth to lime ranges from 15 to 40 inches. The A1 horizon has hue of 10YR, value of 2 or 3 (2 to 5 dry), and chroma of 1. The A2 horizon has hue of 10YR, value of 3 or 4 (4 to 7 dry), and chroma of 1 or 2. The B2t horizon has hue of 10YR or 2.5Y, value of 3 or 4 (4 to 6 dry), and chroma of 1 or 2. In some pedons there is a B3 horizon. The C horizon has hue of 2.5Y, value of 3 to 5 (5 to 7 dry), and chroma of 2 to 4.

Serden series

The Serden series consists of deep, excessively drained, rapidly permeable soils on wind-worked glacial outwash plains. These soils formed in wind-sorted sand. Slope ranges from 0 to 9 percent.

Serden soils commonly are adjacent to Hecla soils. Hecla soils are moderately well drained and have a mollic epipedon. They are in swales and lower lying positions.

Typical pedon of Serden loamy fine sand, 0 to 6 percent slopes, in a pasture, 150 feet north and 150 feet east of the southwest corner of sec. 20, T. 159 N., R. 74 W.

A1—0 to 2 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 4/1) dry; weak medium granular structure; loose, nonsticky and nonplastic; many medium, fine, and very fine roots; neutral; clear smooth boundary.

C1—2 to 24 inches; very dark grayish brown (10YR 3/2) fine sand, light brownish gray (10YR 6/2) dry; single grain; loose, nonsticky and nonplastic; common fine and very fine roots; mildly alkaline; clear wavy boundary.

C2—24 to 52 inches; very dark grayish brown (10YR 3/2) fine sand, grayish brown (10YR 5/2) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; neutral; gradual wavy boundary.

C3—52 to 60 inches; grayish brown (10YR 5/2) fine sand, light brownish gray (10YR 6/2) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; neutral.

The A horizon has hue of 10YR, value of 2 to 4 (3 to 6 dry), and chroma of 1. The C horizon has hue of 10YR or 2.5Y, value of 3 to 6 (5 to 7 dry), and chroma of 2 to 4. It generally is fine sand but in some places it includes subhorizons of sand.

Sioux series

The Sioux series consists of deep, excessively drained, very rapidly permeable soils on outwash plains and glacial stream terraces. The soils formed in glacial outwash. Slope ranges from 0 to 15 percent.

Sioux soils are similar to and commonly are adjacent to Arvilla soils. Unlike Sioux soils, Arvilla soils have a cambic horizon and have gravelly sand at a depth of 14 to 25 inches.

Typical pedon of Sioux loam, 0 to 15 percent slopes, in a cultivated field, 66 feet west and 1,584 feet south of the northeast corner of sec. 18, T. 159 N., R. 83 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; soft, friable, slightly sticky and slightly plastic; common fine roots; common fine pores; neutral; clear smooth boundary.

AC—6 to 8 inches; very dark grayish brown (10YR 3/2) sandy loam, dark brown (10YR 4/3) dry; weak medium granular structure; soft, very friable, slightly sticky and slightly plastic; common fine roots; mildly alkaline; clear smooth boundary.

C—8 to 60 inches; dark brown (10YR 4/3) very gravelly sand, pale brown (10YR 6/3) dry; single grain; loose, nonsticky and nonplastic; lime accumulations on underside of pebbles; about 40 percent coarse fragments; slight effervescence; moderately alkaline.

The solum is 6 to 14 inches thick. Depth to gravelly sand is 6 to 14 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. It is loam, sandy loam, gravelly loam, or gravelly sandy loam. The AC horizon has hue of 10YR, value of 3 or 4 (4 to 6 dry), and chroma of 2 or 3. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4.

Stirum series

The Stirum series consists of deep, poorly drained, moderately slowly permeable over moderately to rapidly permeable soils in slightly depressed areas of sandy outwash and glacio-lacustrine plains. The soils formed in coarse textured or moderately coarse textured sediment. Slope is 0 to 1 percent.

Stirum soils commonly are adjacent to Embden, Hecla, and Letcher soils. Unlike Stirum soils, Embden and Hecla soils do not have a natric horizon, and they are in higher lying positions. Letcher soils are moderately well drained.

Typical pedon of Stirum fine sandy loam, in a pasture, 475 feet east and 15 feet south of the northwest corner of sec. 36, T. 159 N., R. 75 W.

A1—0 to 4 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; moderate medium granular structure; soft, very friable, nonsticky and nonplastic; many medium and fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

A2—4 to 10 inches; very dark gray (10YR 3/1) fine sandy loam, gray (10YR 5/1) dry; ped faces are gray (10YR 5/1) and light gray (10YR 6/1) dry; weak coarse prismatic structure parting to moderate coarse and medium platy; hard, friable, slightly sticky and slightly plastic; many medium and fine roots; strong effervescence; moderately alkaline; clear wavy boundary.

B2t—10 to 18 inches; dark gray (10YR 4/1) fine sandy loam, light gray (10YR 6/1) dry; many fine and medium distinct light brownish gray (2.5Y 6/2) mottles; weak coarse columnar structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and few medium roots; strong effervescence (column interiors have violent effervescence); very strongly alkaline; gradual wavy boundary.

B3g—18 to 28 inches; dark gray (5Y 4/1) fine sandy loam, light gray (5Y 6/1) dry; many large prominent olive yellow (2.5Y 6/6) mottles; weak coarse prismatic structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine and very fine roots; violent effervescence; very strongly alkaline; gradual wavy boundary.

C1—28 to 42 inches; light yellowish brown (2.5Y 6/4) loamy fine sand, pale yellow (2.5Y 7/4) dry; common medium prominent light brownish gray (2.5Y 6/2) mottles; weak coarse prismatic structure; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; strong effervescence; very strongly alkaline; gradual wavy boundary.

C2—42 to 55 inches; light olive brown (2.5Y 5/6) loamy fine sand, olive yellow (2.5Y 6/6) dry; many medium prominent light gray (2.5Y 7/2, dry) mottles; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; strong effervescence; very strongly alkaline; gradual wavy boundary.

C3—55 to 60 inches; olive yellow (2.5Y 6/6) loamy sand, yellow (2.5Y 7/6) dry; many large prominent pale yellow (2.5Y 7/4, dry) mottles; massive; loose, nonsticky and nonplastic; few very fine roots; strong effervescence; moderately alkaline.

The solum is 10 to 30 inches thick. The A1 horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1 or 2. In some pedons there is no A2 horizon. The B2t horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 5 (4 to 7 dry), and chroma of 1 or 2.

Svea series

The Svea series consists of deep, moderately well drained, moderately slowly permeable soils on till plains. The soils formed in till. Slope ranges from 0 to 3 percent.

Svea soils are similar to Barnes soils and commonly are adjacent to Barnes, Hamerly, and Tonka soils. Barnes soils are well drained, and, unlike Svea soils, they have a mollic epipedon that is less than 16 inches thick. They are in higher positions. Hamerly soils do not have a cambic horizon, have a calcic horizon within a depth of 16 inches, and surround depressions. Tonka soils are poorly drained and are in shallow depressions.

Typical pedon of Svea loam, in an area of Barnes-Svea-Tonka complex, 0 to 3 percent slopes, in a cultivated field, 141 feet south and 1,580 feet east of the northwest corner of sec. 28, T. 159 N., R. 83 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to moderate medium granular; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; mildly alkaline; abrupt smooth boundary.

A12—6 to 11 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium prismatic structure parting to moderate medium granular; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; neutral; clear wavy boundary.

B21—11 to 22 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; about 5 percent coarse fragments; neutral; abrupt wavy boundary.

B22—22 to 32 inches; dark brown (10YR 3/3) loam, grayish brown (2.5Y 5/2) dry; few fine distinct yellowish brown (10YR 5/6) and common fine faint olive gray (5Y 4/2) mottles; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few fine roots; about 5 percent coarse fragments; slight effervescence; neutral; gradual wavy boundary.

Cca—32 to 60 inches; olive (5Y 4/3) loam, light brownish gray (2.5Y 6/2) dry; common fine distinct strong brown (7.5YR 5/8) and many medium distinct gray (5Y 5/1) mottles; massive; hard, firm, sticky and plastic; common medium irregularly shaped segregated masses of lime; about 10 percent coarse fragments; strong effervescence; moderately alkaline.

The mollic epipedon is 16 to 30 inches thick. The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1. The B2 horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 4. It is loam or clay loam. In some pedons there is a B3 horizon. The Cca horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 to 4.

Swenoda series

The Swenoda series consists of deep, moderately well drained soils on uplands. Permeability is moderately rapid over moderate or moderately slow. These soils formed in eolian material overlying lacustrine sediment or till. Slope ranges from 0 to 3 percent.

Swenoda soils are similar to Embden and Towner soils and commonly are adjacent to Embden, Hecla, and Wyndmere soils. Embden soils have more sand within a depth of 40 inches than Swenoda soils. Hecla soils contain more sand than Swenoda soils and do not have finer textured material within a depth of 40 inches. Wyndmere soils have a calcic horizon within a depth of 16 inches and are somewhat poorly drained. They are in lower lying positions than Swenoda soils. Towner soils have more sand in the upper part of the profile than Swenoda soils.

Typical pedon of Swenoda fine sandy loam, 0 to 3 percent slopes, in a cultivated field, 2,000 feet north and 150 feet east of the southwest corner of sec. 33, T. 160 N., R. 80 W.

Ap—0 to 7 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many fine and medium roots; neutral; abrupt smooth boundary.

A12—7 to 17 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many fine and medium roots; neutral; clear wavy boundary.

B2—17 to 25 inches; dark grayish brown (10YR 4/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine roots; slight effervescence; mildly alkaline; clear wavy boundary.

C1ca—25 to 33 inches; grayish brown (2.5Y 5/2) fine sandy loam, light gray (2.5Y 7/2) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few fine irregularly shaped soft masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

IIC2—33 to 60 inches; light olive brown (2.5Y 5/4) silt loam, pale yellow (2.5Y 8/4) dry; common medium distinct light brownish gray (2.5Y 6/2) and many medium faint yellowish brown (10YR 5/8) mottles; massive; hard, firm, slightly sticky and slightly plastic; laminated; strong effervescence; moderately alkaline.

The solum is 20 to 40 inches thick. Depth to the finer textured IIC horizon ranges from 20 to 40 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The B horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 6 dry), and chroma of 1 to 3. The IIC horizon has hue of 2.5Y or 5Y, value of 4 to 6 (6 to 8 dry), and chroma of 2 to 4. It is silt loam or silty clay loam lacustrine sediment or loam or clay loam till.

Tonka series

The Tonka series consists of deep, poorly drained, slowly permeable soils in basins and depressions. The soils formed in local alluvium over till or lacustrine sediment. Slope is 0 to 1 percent.

Tonka soils are similar to Parnell and Vallers soils and commonly are adjacent to Barnes, Hamerly, Parnell, and Svea soils. Parnell soils are very poorly drained. They are in deeper depressions than Tonka soils. Barnes soils are well drained, and Svea soils are moderately well drained and are in higher positions. Hamerly soils are somewhat poorly drained and have a calcic horizon within a depth of 16 inches. They surround depressions. Vallers soils have a layer of lime accumulation within a depth of 16 inches.

Typical pedon of Tonka silt loam, in a cultivated field, 1,080 feet west and 155 feet south of the northeast corner of sec. 32, T. 159 N., R. 81 W.

A1—0 to 10 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; moderate very fine granular structure; soft, friable, sticky and plastic; neutral; clear wavy boundary.

A21—10 to 16 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 6/1) dry; common fine distinct yellowish brown (10YR 5/4) dry mottles; moderate thin platy structure; slightly hard, very friable, sticky and plastic; neutral; gradual wavy boundary.

A22—16 to 20 inches; dark gray (10YR 4/1) silty clay loam, gray (10YR 5/1) dry; common fine distinct yellowish brown (10YR 5/4) dry mottles; weak thin platy structure parting to moderate very fine subangular blocky; slightly hard, friable, sticky and plastic; slightly acid; gradual wavy boundary.

B2t—20 to 34 inches; very dark grayish brown (2.5Y 3/2) silty clay, light brownish gray (2.5Y 6/2) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; strong very fine angular blocky structure; very hard, firm, very sticky and very plastic; bleached sand grain coatings on top of peds; slightly acid; gradual wavy boundary.

C1—34 to 38 inches; dark grayish brown (2.5Y 4/2) clay loam, grayish brown (2.5Y 5/2) dry; many medium distinct dark yellowish brown (10YR 4/4) mottles;

massive; hard, friable, slightly sticky and plastic; neutral; gradual wavy boundary.
C2—38 to 60 inches; grayish brown (2.5Y 5/2) clay loam, light brownish gray (2.5Y 6/2) dry; many fine distinct olive brown (2.5Y 4/4) mottles; massive; hard, firm, sticky and plastic; about 5 percent coarse fragments; neutral.

The A1 horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1. The A2 horizon has hue of 10YR or 2.5Y, value of 3 to 5 (5 to 7 dry), and chroma of 2 or less. The B horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 to 4 (4 to 6 dry), and chroma of 1 or 2. In some pedons there is a B3 horizon.

Towner series

The Towner series consists of deep, moderately well drained, rapidly permeable over moderately or moderately slowly permeable soils on uplands. The soils formed in wind- and water-deposited sand overlying till or lacustrine sediment. Slope ranges from 0 to 6 percent.

Towner soils are similar to Hecla and Swenoda soils and commonly are adjacent to Embden, Hecla, and Swenoda soils. Unlike Towner soils, Hecla soils have mottles within a depth of 40 inches and do not have a IIC horizon. Embden and Swenoda soils contain more silt and clay than Towner soils.

Typical pedon of Towner loamy fine sand, 0 to 6 percent slopes, in a cultivated field, 850 feet north and 250 feet west of the southeast corner of sec. 32, T. 160 N., R. 80 W.

Ap—0 to 9 inches; black (10YR 2/1) loamy fine sand, dark gray (10YR 4/1) dry; weak medium granular structure; soft, very friable, nonsticky and nonplastic; few fine roots and many medium roots; neutral; abrupt smooth boundary.
A12—9 to 16 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine roots; neutral; clear wavy boundary.
C1—16 to 32 inches; dark grayish brown (10YR 4/2) loamy fine sand, brown (10YR 5/3) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine roots; mildly alkaline; abrupt wavy boundary.
IIC—32 to 60 inches; light olive brown (2.5Y 5/4) loam, pale yellow (5Y 7/3) dry; massive; hard, firm, sticky and plastic; about 5 percent coarse fragments; strong effervescence; moderately alkaline.

The mollic epipedon is 16 to 30 inches thick. Depth to the IIC horizon ranges from 20 to 40 inches. The A horizon has hue of 10YR, value of 2 to 4 (3 to 6 dry), and chroma of 1 or 2. In some pedons there is a B horizon. The C horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 4. The IIC horizon has hue of 2.5Y or 5Y, value of 4 to 6 (6 to 8 dry), and chroma of 2 to 4. It is loam or clay loam till or silt loam or silty clay loam lacustrine sediment.

Ulen series

The Ulen series consists of deep, somewhat poorly drained, rapidly permeable soils on low-lying sandy lacustrine and glacial outwash plains. The soils formed in sandy glacial outwash deposits. Slope ranges from 0 to 3 percent.

Ulen soils are similar to Arveson soils and commonly are adjacent to Hecla soils. Arveson soils are poorly drained and contain more silt and clay than Ulen soils. They are in depressions. Hecla soils do not have a calcic horizon within a depth of 16 inches. They are in higher positions.

Typical pedon of Ulen loamy fine sand, 0 to 3 percent slopes, in a cultivated field, 1,350 feet south and 1,600 feet west of the northeast corner of sec. 24, T. 159 N., R. 75 W.

Ap—0 to 9 inches; black (10YR 2/1) loamy fine sand, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; common very fine roots; slight effervescence; moderately alkaline; abrupt smooth boundary.
A12ca—9 to 13 inches; very dark gray (10YR 3/1) loamy fine sand, gray (10YR 5/1) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine roots; disseminated lime; strong effervescence; moderately alkaline; clear smooth boundary.
C1ca—13 to 17 inches; dark gray (10YR 4/1) loamy fine sand, light gray (10YR 6/1) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; disseminated lime; violent effervescence; moderately alkaline; gradual wavy boundary.
C2—17 to 24 inches; dark brown (10YR 4/3) loamy fine sand, light brownish gray (2.5Y 6/2) dry; few medium faint brown (10YR 5/3) mottles; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; moderately alkaline; clear smooth boundary.
C3—24 to 41 inches; yellowish brown (10YR 5/6) fine sand, brownish yellow (10YR 6/6) dry; common fine distinct grayish brown (10YR 5/2) mottles; single grain; loose, nonsticky and nonplastic; moderately alkaline; gradual irregular boundary.
C4—41 to 60 inches; light olive brown (2.5Y 5/4) fine sand, light yellowish brown (2.5Y 6/4) dry; common medium distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; single grain; loose, nonsticky and nonplastic; slight effervescence; moderately alkaline.

The mollic epipedon is 10 to 20 inches thick. The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 or 2. The Cca horizon has hue of 10YR or 2.5Y, value of 4 or 5 (5 to 7 dry), and chroma of 1 to 3. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (6 or 7 dry), and chroma of 2 to 6.

Vallers series

The Vallers series consists of deep, poorly drained, moderately slowly permeable soils in depressions, on flats, and on the rim of depressions on glacial moraines. The soils formed in calcareous till. Slope is 0 to 1 percent.

Vallers soils are similar to Tonka and Marysland soils and commonly are adjacent to Barnes, Hamerly, Svea, and Tonka soils. Unlike Vallers soils, Marysland soils have a gravelly IIC horizon. Barnes soils are well drained, and Svea soils are moderately well drained. Tonka soils have an albic horizon. Hamerly soils are somewhat poorly drained and are in higher positions.

Typical pedon of Vallers loam, in a pasture, 430 feet west and 125 feet north of the southeast corner of sec. 20, T. 159 N., R. 82 W.

A1—0 to 10 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to weak fine granular; hard, friable, sticky and plastic; many fine and medium roots; about 10 percent coarse fragments; slight effervescence; mildly alkaline; abrupt wavy boundary.

C1ca—10 to 15 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; few fine faint light olive brown (2.5Y 5/4) mottles; weak coarse prismatic structure parting to weak medium subangular blocky; hard, friable, sticky and plastic; common fine roots; many medium soft masses of lime; about 10 percent gravel; violent effervescence; moderately alkaline; clear wavy boundary.

C2ca—15 to 23 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; common medium distinct light olive brown (2.5Y 5/6) mottles; weak coarse subangular blocky structure; hard, friable, sticky and plastic; common fine roots; many medium soft masses of lime; about 10 percent gravel; violent effervescence; moderately alkaline; clear wavy boundary.

C3—23 to 60 inches; grayish brown (2.5Y 5/2) loam, light gray (5Y 7/2) dry; many medium prominent yellowish brown (10YR 5/6) and common medium distinct gray (5Y 5/1) mottles; massive; hard, friable, sticky and plastic; few fine roots; many large nests of gypsum crystals; about 10 percent coarse fragments; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 16 inches thick. The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 or 4 dry), and chroma of 1 or less. The Cca horizon has hue of 2.5Y or 5Y, value of 3 to 6 (5 to 8 dry), and chroma of 1 or 2. The C horizon has hue of 2.5Y or 5Y, value of 4 to 7 (5 to 7 dry), and chroma of 1 to 3.

Wyndmere series

The Wyndmere series consists of deep, somewhat poorly drained, moderately rapidly permeable soils on sandy outwash plains. The soils formed in calcareous, sandy glacial outwash sediment. Slope is 0 to 1 percent.

Wyndmere soils are similar to Glyndon soils and commonly are adjacent to Egeland and Embden soils. Glyndon soils contain more silt than Wyndmere soils. Egeland soils are well drained, and Embden soils are moderately well drained. Egeland and Embden soils do not have a calcic horizon within a depth of 16 inches, and they are in higher positions than Wyndmere soils.

Typical pedon of Wyndmere fine sandy loam, in a cultivated field, 750 feet east and 550 feet north of the southwest corner of sec. 34, T. 159 N., R. 75 W.

Ap—0 to 7 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak medium granular structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine roots; slight effervescence; moderately alkaline; abrupt smooth boundary.

C1ca—7 to 10 inches; dark gray (10YR 4/1) fine sandy loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many fine and very fine roots; few fine irregularly shaped soft masses of lime; strong effervescence; moderately alkaline; clear wavy boundary.

C2ca—10 to 19 inches; grayish brown (2.5Y 5/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; weak medium and fine subangular blocky structure; slightly hard, very friable, nonsticky and slightly plastic; many very fine and fine roots; disseminated lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C3—19 to 45 inches; light olive brown (2.5Y 5/4) fine sandy loam, light yellowish brown (2.5Y 6/4) dry; weak medium and fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; strong effervescence; moderately alkaline; gradual wavy boundary.

C4—45 to 60 inches; light olive brown (2.5Y 5/4) loamy fine sand, light yellowish brown (2.5Y 6/4) dry; common medium prominent strong brown (7.5YR 5/6) and many large distinct gray (5Y 5/1) mottles; single grain; loose, nonsticky and nonplastic; slight effervescence; moderately alkaline.

The mollic epipedon is 7 to 16 inches thick. The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1. The Cca horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 7 dry), and chroma of 1 or 2. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4.

formation of the soils

Soil is the product of the action of environment on parent material. The characteristics of the soil are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil formed; (3) the plant and animal life on and in the soil; (4) the relief; and (5) the length of time these factors have acted on the soil material.

The active factors of soil formation are climate and plant and animal life. They act on the parent material by determining the nature of weathering and slowly change the parent material into a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by the relief and the parent material. Time is required for the climatic and biological forces to change the parent material and for soil to form. Generally, a long time is required for distinct horizons to develop.

The factors of soil formation are so closely interrelated in their effects on the soil that few general statements can be made about the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil formation are still unknown.

parent material

In Bottineau County, the soils formed in glacial material that derived from preglacial rock. The ice sheet picked up this rock, ground and mixed it, and transported it many miles from its place of origin. As the ice receded, it deposited this ground and mixed rock. Barnes and Kelvin soils formed in the unsorted glacial till. Gardena and Rolla soils formed in material that was sorted by water and deposited in glacial lakes. Serden and Hecla soils formed in material that was sorted by wind and water.

climate

In Bottineau County the climate is cool, dry-subhumid, and continental. Winters are long and cold, and summers are short and warm. Precipitation occurs mainly during the growing season, but it is erratic.

Temperature and precipitation have a direct influence on the weathering processes that affect the parent material. The cool, dry climate limits the depth of leaching, the extent of physical and chemical weathering, and biological processes in the soil. It limits vegetative growth, but it also allows a slow rate of plant decay, thus enabling organic matter to accumulate.

Soils in the Turtle Mountains, for example, Kelvin soils, have undergone a slightly greater degree of leaching because they receive slightly more precipitation than the rest of the county.

plant and animal life

The native vegetation in most of Bottineau County consisted of mid and tall grasses on the prairie. Prairie soils, for example, Barnes and Eckman soils, formed under mid, cool-season grasses. Prairie soils that received extra moisture formed under tall, warm-season grasses.

In the Turtle Mountains, Kelvin and Rolla soils, for example, formed under trees. These soils were subject to a greater amount of leaching.

Plant roots help to keep the soil open and porous. They loosen the soil material and bring minerals from the parent material upward toward the surface. Dead plants or parts of plants contribute organic matter, which bacteria and other micro-organisms help to decompose. By these processes, nutrients leached from the surface layer are replaced.

Earthworms and burrowing animals help to mix the soil material and transfer organic matter below the surface.

Man's activities, particularly in altering drainage, maintaining fertility, and changing the type of vegetation, have an increasingly important effect on soil formation.

relief

Relief influences the formation of soils through its effect on runoff and drainage. Where slopes are steep, most of the precipitation is lost as runoff. Vegetation is sparse, leaching is reduced, and profile development is slow, as in Buse soils. Svea soils, for example, receive more moisture because of their position on the landscape; therefore, they are leached to a greater degree and have a better developed soil profile. Soils that receive extra moisture (as runoff from adjacent soils) and are poorly drained, for example, Colvin soils, have less profile development.

time

Approximately 11,000 years have passed since the ice sheet receded and the processes of soil formation began to act on the parent material and to form the soils in Bottineau County. In geologic terms, this is considered a short period of time, and the soils are considered young.

All the soils formed in deposits that were laid down at approximately the same time. Time, therefore, has had little influence on the relative degree of profile development.

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glossary

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Bottom land. The normal flood plain of a stream, subject to flooding.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15.2 to 38.1 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—
Loose.—Noncoherent when dry or moist; does not hold together in a mass.
Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.
Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.
Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.
Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.
Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
Soft.—When dry, breaks into powder or individual grains under very slight pressure.
Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the removal of water from the soil. Drainage classes are determined on the basis of an overall evaluation of water removal as influenced by climate, slope, and position on the

landscape. Precipitation, runoff, amount of moisture infiltrating the soil, and rate of water movement through the soil affect the degree and duration of wetness. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. The soils in this class generally are free of mottles throughout. They commonly are shallow, very porous, or steep, or a combination of these.

Somewhat excessively drained.—Water is removed from the soil rapidly. The soils in this class generally are free of mottles throughout. They commonly are shallow or moderately deep, very porous, or steep, or a combination of these.

Well drained.—Water is removed from the soil so readily that the upper 40 inches generally does not have the mottles or dull colors related to wetness.

Moderately well drained.—Water is removed from the soil so slowly that the upper 20 to 40 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Somewhat poorly drained.—Water is removed from the soil so slowly that the upper 10 to 20 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Poorly drained.—Water is removed so slowly that either the soil is periodically saturated or the upper 10 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water is at or on the surface most of the time. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Fast intake (in tables). The rapid movement of water into the soil.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Fine textured soil. Sandy clay, silty clay, and clay.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial melt water. Many deposits are interbedded or laminated.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material.

Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Sandy loam and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by glacial melt water.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Pitting (in tables). Pits caused by melting ground ice. They form on the soil after plant cover is removed.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Ponding. Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability or an impermeable layer near the surface, the soil may not adequately filter effluent from a waste disposal system.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Sodicity. The degree to which a soil is affected by exchangeable sodium. Sodicity is expressed as a sodium absorption ratio (SAR) of a saturation extract, or the ratio of Na^+ to $Ca^{++} + Mg^{++}$. The degrees of sodicity are—

	SAR
Slight	less than 13:1
Moderate	13-30:1
Strong	more than 30:1

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the

underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A1, A2, or A3) below the surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A horizon. Includes all subdivisions of this horizon (A1, A2, and A3).

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-74 at Bottineau, North Dakota]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days[1]	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January	10.6	-10.3	.1	42	-40	0	.46	.13	.71	2	6.8
February	18.0	-3.4	7.3	45	-33	0	.30	.07	.48	1	4.4
March	29.6	9.3	19.5	60	-25	35	.50	.15	.77	1	5.1
April	49.5	27.5	38.5	81	5	94	1.15	.37	1.77	4	3.0
May	64.3	39.2	51.8	90	19	371	2.19	.70	3.37	5	.2
June	74.2	49.5	61.9	95	32	657	3.48	1.59	5.01	7	.0
July	80.0	54.0	67.0	99	39	837	2.83	1.28	4.09	6	.0
August	80.0	52.4	66.2	99	37	812	2.92	.92	4.51	5	.0
September	66.7	40.8	53.8	94	21	420	1.86	.40	2.99	4	.2
October	55.6	30.6	43.1	85	10	189	1.01	.20	1.63	3	1.9
November	33.5	14.2	23.9	63	-17	18	.44	.16	.66	2	4.5
December	19.0	-.6	9.2	45	-33	0	.38	.12	.57	1	5.0
Yearly:											
Average	48.4	26.5	36.9	---	---	---	---	---	---	---	---
Extreme	---	---	---	99	-40	---	---	---	---	---	---
Total	---	---	---	---	---	3,433	17.52	12.71	21.96	41	31.1

[1]A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (40° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1951-74 at Bottineau, North Dakota]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 13	May 29	June 4
2 years in 10 later than--	May 9	May 24	May 30
5 years in 10 later than--	May 1	May 14	May 23
First freezing temperature in fall:			
1 year in 10 earlier than--	September 16	September 7	September 3
2 years in 10 earlier than--	September 22	September 13	September 7
5 years in 10 earlier than--	October 2	September 23	September 14

TABLE 3.--GROWING SEASON

[Recorded in the period 1951-74 at Bottineau, North Dakota]

Probability	Length of growing season if daily minimum temperature is--		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	136	111	98
8 years in 10	142	117	103
5 years in 10	153	131	114
2 years in 10	164	144	124
1 year in 10	170	150	130

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
1	Tonka silt loam	12,080	1.1
2	Parnell silty clay loam	7,110	0.7
5	Pits, gravel	630	0.1
6	Eramosh peat	4,900	0.4
10	Svea loam, 0 to 3 percent slopes	4,330	0.4
11	Svea-Tonka complex, 0 to 3 percent slopes	3,140	0.3
12	Barnes-Svea-Tonka complex, 0 to 3 percent slopes	233,860	21.4
12B	Barnes-Svea-Tonka complex, 0 to 6 percent slopes	19,210	1.8
13	Barnes loam, 0 to 3 percent slopes	86,580	7.9
13B	Barnes loam, 3 to 6 percent slopes	6,640	0.6
14C	Barnes-Buse loams, 3 to 9 percent slopes	10,850	1.0
15E	Buse-Barnes loams, 9 to 25 percent slopes	11,000	1.0
17	Hamerly-Tonka complex, 0 to 3 percent slopes	45,340	4.2
19	Hamerly loam, 0 to 3 percent slopes	11,010	1.0
20	Hamerly loam, saline, 0 to 3 percent slopes	3,400	0.3
21	Vallers loam	2,450	0.2
25	Fargo silty clay	27,680	2.5
26	Fargo and Hegne silty clays, wet	6,280	0.6
27	Hegne silty clay	4,980	0.5
28	Hegne silty clay, saline	1,250	0.1
30	Overly silty clay loam	22,370	2.0
31	Bearden silty clay loam	11,610	1.1
33	Colvin silty clay loam	7,530	0.7
34	Colvin silty clay loam, saline	5,810	0.5
36	Overly-Great Bend silty clay loams, 0 to 3 percent slopes	17,890	1.6
40	Gardena silt loam, 0 to 3 percent slopes	56,950	5.2
42B	Eckman silt loam, 3 to 6 percent slopes	7,900	0.7
45	Glyndon silt loam	26,270	2.4
46	Glyndon and Bearden soils, saline	3,690	0.3
50	Embden fine sandy loam, 0 to 3 percent slopes	32,980	3.0
51B	Egeland fine sandy loam, 3 to 6 percent slopes	8,630	0.8
53	Wyndmere fine sandy loam	21,160	1.9
54	Ulen loamy fine sand, 0 to 3 percent slopes	17,360	1.6
55	Hecla loamy fine sand, 0 to 3 percent slopes	28,210	2.6
56B	Maddock loamy fine sand, 3 to 6 percent slopes	1,540	0.1
61B	Hecla loamy fine sand, 1 to 6 percent slopes	3,590	0.3
62B	Serden loamy fine sand, 0 to 6 percent slopes	1,100	0.1
64B	Towner loamy fine sand, 0 to 6 percent slopes	6,410	0.6
65	Swenoda fine sandy loam, 0 to 3 percent slopes	33,350	3.1
69	Arveson loam	10,050	0.9
71	Arveson loam, wet	2,120	0.2
73	Letcher fine sandy loam, 0 to 3 percent slopes	2,770	0.3
74B	Cresbard-Svea loams, 0 to 6 percent slopes	26,500	2.4
75	Aberdeen-Overly silt loams	37,670	3.4
79	Divide loam	6,170	0.6
80	Marysland loam	3,950	0.4
82B	Arvilla sandy loam, 0 to 6 percent slopes	23,220	2.1
83D	Sioux loam, 0 to 15 percent slopes	6,800	0.6
86C	Bottineau loam, 3 to 9 percent slopes	5,290	0.5
86E	Bottineau loam, 9 to 25 percent slopes	13,500	1.2
87C	Kelvin loam, 3 to 9 percent slopes	17,700	1.6
87E	Kelvin loam, 9 to 25 percent slopes	30,470	2.8
89B	Rolla silty clay, 0 to 6 percent slopes	5,980	0.5
90E	Bottineau-Buse loams, 9 to 25 percent slopes	5,150	0.5
94C	Metigoshe coarse sandy loam, 3 to 9 percent slopes	1,860	0.2
94E	Metigoshe coarse sandy loam, 9 to 25 percent slopes	1,550	0.1
97	Aberdeen-Exline silt loams	9,580	0.9
100	Colvin silty clay loam, channeled	7,160	0.7
103	Eramosh peat, ponded	3,400	0.3
104	Parnell silty clay loam, ponded	15,090	1.4
110	Exline silt loam	23,650	2.2
111	Stirum fine sandy loam	3,300	0.3
116C	Serden-Hecla-Blownout land complex, 0 to 9 percent slopes	2,810	0.3
	Water	9,670	0.9
	Total	1,092,480	100.0

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Spring wheat	Oats	Barley	Flax	Grass-legume hay	Rye	Sunflowers
	Bu	Bu	Bu	Bu	Ton	Bu	Lb
1---------- Tonka	16	34	26	8	2.1	22	800
2---------- Parnell	---	---	---	---	---	---	---
5*. Pits							
6---------- Eramosh	---	---	---	---	---	---	---
10---------- Svea	38	80	61	19	2.9	52	2,000
11---------- Svea-Tonka	32	67	51	16	2.6	44	1,800
12---------- Barnes-Svea-Tonka	36	75	57	18	2.8	49	1,880
12B---------- Barnes-Svea-Tonka	33	70	53	17	2.7	46	1,680
13---------- Barnes	33	70	53	17	2.7	46	1,680
13B---------- Barnes	30	63	48	15	2.5	41	1,580
14C---------- Barnes-Buse	21	44	33	10	1.7	29	1,060
15E---------- Buse-Barnes	---	---	---	---	---	---	---
17---------- Hamerly-Tonka	28	59	45	14	2.4	39	1,580
19---------- Hamerly	34	71	54	17	2.7	47	1,700
20---------- Hamerly	22	46	35	11	1.9	30	900
21---------- Vallers	16	34	26	8	2.1	22	800
25---------- Fargo	36	75	57	18	2.8	49	1,800
26---------- Fargo and Hegne	---	---	---	---	---	---	---
27---------- Hegne	36	75	57	18	2.8	49	1,800
28---------- Hegne	22	46	35	11	1.9	30	900
30---------- Overly	40	84	64	20	3.0	55	2,000

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Spring wheat	Oats	Barley	Flax	Grass-legume hay	Rye	Sunflowers
	Bu	Bu	Bu	Bu	Ton	Bu	Lb
31--Bearden	38	80	61	19	2.9	52	1,800
33--Colvin	16	34	26	8	2.1	22	800
34--Colvin	---	---	---	---	---	---	---
36--Overly-Great Bend	36	76	58	18	2.8	50	1,880
40--Gardena	40	84	64	20	3.0	55	2,000
42B--Eckman	33	69	53	16	2.6	45	1,600
45--Glyndon	38	80	61	19	2.9	52	1,800
46--Glyndon and Bearden	26	55	42	13	2.3	36	1,100
50--Embden	30	63	48	15	2.5	41	1,900
51B--Egeland	24	50	38	12	2.1	33	1,200
53--Wyndmere	28	59	45	14	2.4	39	1,700
54--Ulen	20	42	32	10	1.7	28	1,400
55--Hecla	19	40	31	10	1.7	26	1,400
56B--Maddock	14	29	22	7	1.3	19	700
61B--Hecla	---	---	---	---	---	---	---
62B--Serden	---	---	---	---	---	---	---
64B--Towner	22	46	35	11	1.9	30	1,400
65--Swenoda	32	67	51	16	2.6	44	1,700
69--Arveson	16	34	26	8	2.1	22	800
71--Arveson	---	---	---	---	---	---	---
73--Letcher	14	29	22	7	1.3	19	500
74B--Cresbard-Svea	31	66	50	16	2.6	43	1,500
75--Aberdeen-Overly	35	74	56	18	2.8	48	1,580
79--Divide	26	55	42	13	2.3	36	1,000

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Spring wheat	Oats	Barley	Flax	Grass-legume hay	Rye	Sunflowers
	Bu	Bu	Bu	Bu	Ton	Bu	Lb
80--Marysland	16	34	26	8	2.1	22	800
82B--Arvilla	18	38	29	9	1.5	25	700
83D--Sioux	---	---	---	---	---	---	---
86C--Bottineau	28	59	45	14	2.4	39	1,400
86E--Bottineau	---	---	---	---	---	---	---
87C--Kelvin	28	59	45	14	2.4	39	1,400
87E--Kelvin	---	---	---	---	---	---	---
89B--Rolla	32	67	51	16	2.6	44	1,600
90E--Bottineau-Buse	---	---	---	---	---	---	---
94C--Metigoshe	18	38	29	9	1.5	25	700
94E--Metigoshe	---	---	---	---	---	---	---
97--Aberdeen-Exline	16	34	26	8	1.3	22	660
100--Colvin	---	---	---	---	---	---	---
103--Eramosh	---	---	---	---	---	---	---
104--Parnell	---	---	---	---	---	---	---
110--Exline	---	---	---	---	---	---	---
111--Stirum	---	---	---	---	---	---	---
116C--Serden-Hecla-Blownout land	---	---	---	---	---	---	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average height in feet, of--				
	<8	9-15	16-25	26-35	>35
1. Tonka					
2. Parnell					
5*. Pits					
6. Eramosh					
10---------- Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow-----	Eastern cottonwood.
11*: Svea----------	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow-----	Eastern cottonwood.
Tonka.					
12*, 12B*: Barnes----------	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Svea----------	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow-----	Eastern cottonwood.
Tonka.					
13, 13B---------- Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
14C*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
Buse	Siberian peashrub, Tatarian honeysuckle.	Ponderosa pine, green ash, Russian-olive, eastern redcedar, Rocky Mountain juniper.	Siberian elm	---	---
15E*:					
Buse.					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian-olive.	---	---
17*:					
Hamerly	---	Redosier dogwood, ponderosa pine, Tatarian honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Tonka.					
19 Hamerly	---	Redosier dogwood, ponderosa pine, Tatarian honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
20. Hamerly					
21. Vallers					
25 Fargo	---	Common chokecherry, Rocky Mountain juniper, American plum, Siberian peashrub, Tatarian honeysuckle.	Ponderosa pine, Black Hills spruce, blue spruce.	Siberian elm, green ash.	Eastern cottonwood.

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
26*: Fargo. Hegne.					
27---------- Hegne	American plum-----	Eastern redcedar, common chokecherry, lilac, Tatarian honeysuckle, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
28. Hegne					
30---------- Overly	---	Tatarian honeysuckle, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
31---------- Bearden	---	Redosier dogwood, ponderosa pine, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum, Peking cotoneaster.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
33---------- Colvin	---	Tatarian honeysuckle, Siberian peashrub, common chokecherry, lilac.	Siberian crabapple, Black Hills spruce, eastern redcedar, blue spruce.	Green ash, golden willow.	Eastern cottonwood, Siberian elm.
34. Colvin					
36*: Overly----------	---	Tatarian honeysuckle, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
36*: Great Bend	---	Eastern redcedar, lilac, Tatarian honeysuckle, Siberian peashrub, American plum, common chokecherry.	Green ash, bur oak, ponderosa pine, Black Hills spruce, Russian-olive, Siberian crabapple.	---	---
40 Gardena	---	Tatarian honeysuckle, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
42B Eckman	---	Eastern redcedar, American plum, lilac, Tatarian honeysuckle, Siberian peashrub, redosier dogwood.	Ponderosa pine, green ash, bur oak, Black Hills spruce, Russian-olive, Siberian crabapple.	---	---
45 Glyndon	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Tatarian honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
46*: Glyndon. Bearden.					
50 Embden	---	Peking cotoneaster, ponderosa pine, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
51B---------- Egeland	Silver buffaloberry, Tatarian honeysuckle.	Siberian crabapple, eastern redcedar, common chokecherry, Siberian peashrub, lilac, American plum.	Green ash, bur oak, ponderosa pine, Russian-olive.	---	---
53---------- Wyndmere	---	Redosier dogwood, ponderosa pine, American plum, Tatarian honeysuckle, eastern redcedar, Peking cotoneaster, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
54---------- Ulen	Tatarian honeysuckle.	Eastern redcedar, Siberian crabapple, common chokecherry, lilac, American plum, Siberian peashrub, silver buffaloberry.	Green ash, bur oak, ponderosa pine, Russian-olive.	---	---
55---------- Hecla	---	Ponderosa pine, eastern redcedar, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum, Peking cotoneaster, redosier dogwood.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
56B---------- Maddock	---	Silver buffaloberry, common chokecherry, Siberian peashrub, eastern redcedar, Tatarian honeysuckle, American plum, Siberian crabapple, lilac.	Bur oak, green ash, ponderosa pine, Russian-olive.	---	---
61B. Hecla					

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
62B. Serden					
64B---------- Towner	---	Lilac, eastern redcedar, Siberian peashrub, common chokecherry, Tatarian honeysuckle, American plum, silver buffaloberry, Siberian crabapple.	Ponderosa pine, green ash, Russian-olive, bur oak.	---	---
65---------- Swenoda	Tatarian honeysuckle.	Siberian crabapple, eastern redcedar, common chokecherry, Siberian peashrub, silver buffaloberry, lilac, American plum.	Green ash, bur oak, ponderosa pine, Russian-olive.	---	---
69, 71. Arveson					
73---------- Letcher	Green ash, silver buffaloberry, Russian-olive, eastern redcedar, Rocky Mountain juniper, Siberian peashrub.	Siberian elm, ponderosa pine.	---	---	---
74B*: Cresbard---------	Tatarian honeysuckle, Peking cotoneaster.	Russian-olive, common chokecherry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---
Svea----------	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Tatarian honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow-----	Eastern cottonwood.
75*: Aberdeen---------	Tatarian honeysuckle, Peking cotoneaster.	Russian-olive, common hackberry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
75*: Overly	---	Tatarian honeysuckle, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
79 Divide	---	Redosier dogwood, ponderosa pine, Tatarian honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
80. Marysland					
82B Arvilla	Tatarian honeysuckle, Siberian peashrub, lilac, silver buffaloberry.	Green ash, Russian-olive, Siberian crabapple, eastern redcedar, Rocky Mountain juniper, common chokecherry.	Ponderosa pine	---	---
83D. Sioux					
86C Bottineau	---	Lilac, eastern redcedar, redosier dogwood, Siberian peashrub, Tatarian honeysuckle, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce, Russian-olive.	---	---
86E. Bottineau					
87C Kelvin	---	American plum, eastern redcedar, lilac, Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce, Russian-olive.	---	---
87E. Kelvin					

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
89B---------- Rolla	---	Russian-olive, common chokecherry, eastern redcedar, lilac, silver buffaloberry, Siberian peashrub, Tatarian honeysuckle, Peking cotoneaster.	Siberian elm, green ash, ponderosa pine, Siberian crabapple.	---	---
90E*: Bottineau.					
Buse.					
94C---------- Metigoshe	---	Eastern redcedar, Siberian crabapple, common chokecherry, American plum, lilac, Siberian peashrub, silver buffaloberry, Tatarian honeysuckle.	Green ash, ponderosa pine, Russian-olive, bur oak.	---	---
94E. Metigoshe					
97*: Aberdeen---------	Tatarian honeysuckle, Peking cotoneaster.	Russian-olive, common hackberry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---
Exline.					
100. Colvin					
103. Eramosh					
104. Parnell					
110. Exline					
111. Stirum					
116C*: Serden.					
Hecla.					
Blownout land.					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
1---------- Tonka	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
2---------- Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
5*. Pits				
6---------- Eramosh	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.
10---------- Svea	Slight----------	Slight----------	Slight----------	Slight.
11*:				
Svea----------	Slight----------	Slight----------	Slight----------	Slight.
Tonka----------	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
12*:				
Barnes----------	Slight----------	Slight----------	Slight----------	Slight.
Svea----------	Slight----------	Slight----------	Slight----------	Slight.
Tonka----------	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
12B*:				
Barnes----------	Slight----------	Slight----------	Moderate: slope.	Slight.
Svea----------	Slight----------	Slight----------	Moderate: slope.	Slight.
Tonka----------	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
13---------- Barnes	Slight----------	Slight----------	Slight----------	Slight.
13B---------- Barnes	Slight----------	Slight----------	Moderate: slope.	Slight.
14C*:				
Barnes----------	Slight----------	Slight----------	Severe: slope.	Slight.
Buse----------	Slight----------	Slight----------	Severe: slope.	Slight.
15E*:				
Buse----------	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Barnes----------	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
17*:				
Hamerly----------	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.

See footnote at end of table.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
17*: Tonka	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
19 Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
20 Hamerly	Severe: excess salts.	Severe: excess salts.	Severe: excess salts.	Slight.
21 Vallers	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
25 Fargo	Severe: wetness, too clayey.	Severe: wetness, too clayey.	Severe: too clayey, wetness.	Severe: wetness, too clayey.
26*: Fargo	Severe: ponding, too clayey.	Severe: ponding, too clayey.	Severe: too clayey, ponding.	Severe: ponding, too clayey.
Hegne	Severe: ponding, too clayey.	Severe: ponding, too clayey, excess humus.	Severe: too clayey, excess humus, ponding.	Severe: ponding, too clayey, excess humus.
27 Hegne	Severe: wetness, percs slowly.	Severe: too clayey, percs slowly.	Severe: too clayey, wetness, percs slowly.	Severe: too clayey.
28 Hegne	Severe: wetness, too clayey.	Severe: too clayey, excess humus.	Severe: too clayey, excess humus, wetness.	Severe: too clayey, excess humus.
30 Overly	Slight	Slight	Slight	Slight.
31 Bearden	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness.
33 Colvin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
34 Colvin	Severe: ponding, excess salts.	Severe: ponding, excess salts.	Severe: ponding, excess salts.	Severe: ponding.
36*: Overly	Slight	Slight	Slight	Slight.
Great Bend	Slight	Slight	Slight	Slight.
40 Gardena	Slight	Slight	Slight	Slight.
42B Eckman	Slight	Slight	Moderate: slope.	Slight.
45 Glyndon	Slight	Slight	Slight	Slight.

See footnote at end of table.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
46*:				
Glyndon	Severe: excess salts.	Severe: excess salts.	Severe: excess salts.	Slight.
Bearden	Severe: excess salts.	Severe: excess salts.	Severe: excess salts.	Slight.
50 Embden	Slight	Slight	Slight	Slight.
51B Egeland	Slight	Slight	Moderate: slope.	Slight.
53 Wyndmere	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight.
54 Ulen	Slight	Slight	Slight	Slight.
55 Hecla	Slight	Slight	Slight	Slight.
56B Maddock	Slight	Slight	Moderate: slope.	Slight.
61B Hecla	Slight	Slight	Moderate: slope.	Slight.
62B Serden	Slight	Slight	Moderate: slope.	Slight.
64B Towner	Slight	Slight	Moderate: slope.	Slight.
65 Swenoda	Slight	Slight	Slight	Slight.
69 Arveson	Severe: wetness, excess humus.	Severe: excess humus.	Severe: excess humus, wetness.	Severe: excess humus.
71 Arveson	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.
73 Letcher	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
74B*:				
Cresbard	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Svea	Slight	Slight	Moderate: slope.	Slight.
75*:				
Aberdeen	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Overly	Slight	Slight	Slight	Slight.
79 Divide	Slight	Slight	Slight	Slight.
80 Marysland	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.

See footnote at end of table.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
82B---- Arvilla	Slight----	Slight----	Moderate: slope.	Slight.
83D---- Sioux	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
86C---- Bottineau	Slight----	Slight----	Severe: slope.	Slight.
86E---- Bottineau	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
87C---- Kelvin	Slight----	Slight----	Severe: slope.	Slight.
87E---- Kelvin	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
89B---- Rolla	Moderate: percs slowly, too clayey.	Moderate: too clayey, percs slowly.	Moderate: slope, too clayey, percs slowly.	Moderate: too clayey.
90E*: Bottineau----	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Buse----	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
94C---- Metigoshe	Slight----	Slight----	Severe: slope.	Slight.
94E---- Metigoshe	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
97*: Aberdeen----	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Exline----	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
100---- Colvin	Severe: ponding, flooding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
103---- Eramosh	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.
104---- Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
110---- Exline	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
111---- Stirum	Severe: ponding, excess sodium.	Severe: ponding, excess sodium.	Severe: ponding, excess sodium.	Severe: ponding.
116C*: Serden----	Slight----	Slight----	Severe: slope.	Slight.
Hecla----	Slight----	Slight----	Severe: slope.	Slight.
Blownout land.				

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
1---------- Tonka	Poor	Fair	Fair	Poor	Good	Good	Poor	Good	Poor.
2---------- Parnell	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
5*. Pits									
6---------- Eramosh	Very poor	Poor	Poor	Poor	Good	Good	Very poor	Good	Very poor.
10---------- Svea	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
11*:									
Svea----------	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
Tonka----------	Poor	Fair	Fair	Poor	Good	Good	Poor	Good	Poor.
12*:									
Barnes----------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Svea----------	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
Tonka----------	Poor	Fair	Fair	Poor	Good	Good	Poor	Good	Poor.
12B*:									
Barnes----------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Svea----------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Tonka----------	Poor	Fair	Fair	Poor	Good	Good	Poor	Good	Poor.
13, 13B---------- Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
14C*:									
Barnes----------	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Buse----------	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
15E*:									
Buse----------	Poor	Poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Barnes----------	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
17*:									
Hamerly----------	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Tonka----------	Poor	Fair	Fair	Poor	Good	Good	Poor	Good	Poor.
19---------- Hamerly	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
20---------- Hamerly	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Fair	Fair.
21---------- Vallers	Poor	Fair	Fair	Fair	Good	Good	Poor	Good	Fair.
25---------- Fargo	Good	Good	Fair	Poor	Poor	Good	Fair	Fair	Poor.

See footnote at end of table.

TABLE 8.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
26*:									
Fargo	Very poor	Poor	Fair	Poor	Poor	Good	Poor	Fair	Poor.
Hegne	Very poor	Poor	Fair	Poor	Poor	Good	Poor	Fair	Poor.
27--- Hegne	Good	Good	Fair	Poor	Poor	Good	Fair	Fair	Poor.
28--- Hegne	Fair	Fair	Fair	Very poor	Poor	Good	Fair	Fair	Poor.
30--- Overly	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
31--- Bearden	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
33--- Colvin	Poor	Fair	Fair	Fair	Good	Good	Poor	Good	Fair.
34--- Colvin	Very poor	Poor	Poor	Poor	Good	Good	Very poor	Good	Poor.
36*:									
Overly	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
Great Bend	Good	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Good.
40--- Gardena	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
42B--- Eckman	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
45--- Glyndon	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
46*:									
Glyndon	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Fair	Poor.
Bearden	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Fair	Poor.
50--- Embden	Fair	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
51B--- Egeland	Fair	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
53--- Wyndmere	Fair	Good	Good	Fair	Fair	Poor	Good	Poor	Fair.
54--- Ulen	Fair	Good	Good	Fair	Poor	Poor	Fair	Poor	Fair.
55--- Hecla	Poor	Fair	Good	Fair	Poor	Very poor	Fair	Very poor	Good.
56B--- Maddock	Poor	Fair	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
61B--- Hecla	Poor	Fair	Good	Fair	Poor	Very poor	Fair	Very poor	Good.
62B--- Serden	Poor	Fair	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
64B---------- Towner	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
65---------- Swenoda	Good	Good	Good	Fair	Poor	Poor	Good	Very poor	Good.
69---------- Arveson	Poor	Fair	Fair	Fair	Good	Good	Poor	Good	Fair.
71---------- Arveson	Very poor	Poor	Poor	Poor	Good	Good	Very poor	Good	Poor.
73---------- Letcher	Poor	Fair	Good	Very poor	Very poor	Very poor	Poor	Very poor	Fair.
74B*:									
Cresbard----------	Fair	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Fair.
Svea----------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
75*:									
Aberdeen----------	Fair	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Fair.
Overly----------	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
79---------- Divide	Fair	Fair	Good	Fair	Fair	Very poor	Fair	Poor	Fair.
80---------- Marysland	Poor	Fair	Fair	Fair	Good	Good	Poor	Good	Fair.
82B---------- Arvilla	Poor	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Fair.
83D---------- Sioux	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
86C---------- Bottineau	Fair	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
86E---------- Bottineau	Poor	Fair	Good	Good	Very poor	Very poor	Fair	Very poor	Good.
87C---------- Kelvin	Fair	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
87E---------- Kelvin	Poor	Fair	Good	Good	Very poor	Very poor	Fair	Very poor	Good.
89B---------- Rolla	Good	Good	Fair	Good	Poor	Very poor	Good	Very poor	Fair.
90E*:									
Bottineau----------	Poor	Fair	Good	Good	Very poor	Very poor	Fair	Very poor	Good.
Buse----------	Poor	Poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
94C---------- Metigoshe	Poor	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Fair.
94E---------- Metigoshe	Poor	Fair	Fair	Poor	Very poor	Very poor	Poor	Very poor	Fair.
97*:									
Aberdeen----------	Fair	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Fair.
Exline----------	Very poor	Very poor	Very poor	Very poor	Very poor	Fair	Very poor	Poor	Very poor.

See footnote at end of table.

TABLE 8.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba-ceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
100---------- Colvin	Poor	Fair	Fair	Fair	Good	Good	Poor	Good	Fair.
103---------- Eramosh	Very poor	Very poor	Very poor	Very poor	Good	Good	Very poor	Good	Very poor.
104---------- Parnell	Very poor	Very poor	Very poor	Very poor	Good	Good	Very poor	Good	Very poor.
110---------- Exline	Very poor	Very poor	Very poor	Very poor	Very poor	Fair	Very poor	Poor	Poor.
111---------- Stirum	Very poor	Very poor	Very poor	Very poor	Good	Fair	Very poor	Fair	Poor.
116C*:									
Serden----------	Poor	Fair	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Hecla----------	Poor	Fair	Good	Fair	Poor	Very poor	Fair	Very poor	Good.
Blownout land.									

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
1---- Tonka	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.
2---- Parnell	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, low strength, frost action.
5*. Pits					
6---- Eramosh	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.
10---- Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
11*:					
Svea----	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
Tonka----	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.
12*:					
Barnes----	Slight----	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, frost action.
Svea----	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
Tonka----	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.
12B*:					
Barnes----	Slight----	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
Svea----	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell, slope.	Severe: low strength.
Tonka----	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.
13---- Barnes	Slight----	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, frost action.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
13B---------- Barnes	Slight----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
14C*: Barnes----------	Slight----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
Buse----------	Slight----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
15E*: Buse----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Barnes----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
17*: Hamerly----------	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
Tonka----------	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.
19, 20---------- Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
21---------- Vallers	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.
25---------- Fargo	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, wetness.
26*: Fargo----------	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.
Hegne----------	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, shrink-swell.
27---------- Hegne	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, shrink-swell.
28---------- Hegne	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, shrink-swell.
30---------- Overly	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.
31---------- Bearden	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
33--- Colvin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, wetness, frost action.
34--- Colvin	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding.
36*:					
Overly---	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.
Great Bend---	Slight---	Slight---	Slight---	Slight---	Severe: low strength, frost action.
40--- Gardena	Moderate: wetness.	Slight---	Moderate: wetness.	Slight---	Severe: frost action.
42B--- Eckman	Slight---	Slight---	Slight---	Moderate: slope.	Severe: frost action.
45--- Glyndon	Severe: cutbanks cave.	Slight---	Moderate: wetness.	Slight---	Severe: frost action.
46*:					
Glyndon---	Severe: cutbanks cave.	Slight---	Moderate: wetness.	Slight---	Severe: frost action.
Bearden---	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.
50--- Embden	Severe: cutbanks cave.	Slight---	Moderate: wetness.	Slight---	Moderate: frost action.
51B--- Egeland	Severe: cutbanks cave.	Slight---	Slight---	Moderate: slope.	Slight.
53--- Wyndmere	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.
54--- Ulen	Severe: cutbanks cave.	Slight---	Moderate: wetness.	Slight---	Moderate: frost action.
55--- Hecla	Severe: cutbanks cave.	Slight---	Moderate: wetness.	Slight---	Moderate: frost action.
56B--- Maddock	Severe: cutbanks cave.	Slight---	Slight---	Moderate: slope.	Slight.
61B--- Hecla	Severe: cutbanks cave.	Slight---	Moderate: wetness.	Slight---	Moderate: frost action.
62B--- Serden	Severe: cutbanks cave.	Slight---	Slight---	Slight---	Slight.
64B--- Towner	Severe: cutbanks cave.	Slight---	Moderate: wetness, shrink-swell.	Slight---	Moderate: frost action.
65--- Swenoda	Moderate: wetness.	Slight---	Moderate: wetness, shrink-swell.	Slight---	Moderate: frost action.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
69---- Arveson	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.
71---- Arveson	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.
73---- Letcher	Moderate: wetness.	Slight----	Moderate: wetness.	Slight----	Moderate: frost action.
74B*: Cresbard----	Moderate: too clayey.	Severe: shrink-swell.	Moderate: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Svea----	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
75*: Aberdeen----	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Overly----	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.
79---- Divide	Severe: cutbanks cave.	Slight----	Moderate: wetness.	Slight----	Moderate: low strength, frost action.
80---- Marysland	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.
82B---- Arvilla	Severe: cutbanks cave.	Slight----	Slight----	Slight----	Slight.
83D---- Sioux	Severe: cutbanks cave.	Slight----	Slight----	Moderate: slope.	Slight.
86C---- Bottineau	Slight----	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
86E---- Bottineau	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
87C---- Kelvin	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
87E---- Kelvin	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
89B---- Rolla	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
90E*: Bottineau----	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Buse----	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
94C---------- Metigoshe	Severe: cutbanks cave.	Slight----------	Slight----------	Moderate: slope.	Slight.
94E---------- Metigoshe	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
97*: Aberdeen---------	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Exline----------	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
100---------- Colvin	Severe: ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: low strength, ponding, frost action.
103---------- Eramosh	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.
104---------- Parnell	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, low strength, frost action.
110---------- Exline	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
111---------- Stirum	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
116C*: Serden----------	Severe: cutbanks cave.	Slight----------	Slight----------	Moderate: slope.	Slight.
Hecla----------	Severe: cutbanks cave.	Slight----------	Moderate: wetness.	Moderate: slope.	Moderate: frost action.
Blownout land.					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1---------- Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
2---------- Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
5*. Pits					
6---------- Eramosh	Severe: ponding.	Severe: excess humus, ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
10---------- Svea	Severe: percs slowly.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
11*: Svea----------	Severe: percs slowly.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
Tonka----------	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
12*: Barnes----------	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight----------	Fair: too clayey.
Svea----------	Severe: percs slowly.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
Tonka----------	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
12B*: Barnes----------	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight----------	Fair: too clayey.
Svea----------	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
Tonka----------	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
13---------- Barnes	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight----------	Fair: too clayey.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
13B---------- Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight----------	Fair: too clayey.
14C*: Barnes----------	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight----------	Fair: too clayey.
Buse----------	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight----------	Fair: too clayey.
15E*: Buse----------	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Barnes----------	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
17*: Hamerly----------	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Tonka----------	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
19, 20---------- Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
21---------- Vallers	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
25---------- Fargo	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
26*: Fargo----------	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
Hegne----------	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
27---------- Hegne	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
28---------- Hegne	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
30---------- Overly	Severe: percs slowly.	Slight----------	Moderate: too clayey.	Slight----------	Poor: thin layer.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
31---------- Bearden	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
33---------- Colvin	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
34---------- Colvin	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
36*: Overly----------	Severe: percs slowly.	Slight----------	Moderate: too clayey.	Slight----------	Poor: thin layer.
Great Bend---------	Severe: percs slowly.	Moderate: seepage.	Slight----------	Slight----------	Good.
40---------- Gardena	Moderate: wetness.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Good.
42B---------- Eckman	Slight----------	Moderate: seepage, slope.	Slight----------	Slight----------	Good.
45---------- Glyndon	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Fair: wetness.
46*: Glyndon----------	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Fair: too sandy, wetness.
Bearden----------	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
50---------- Embden	Moderate: wetness.	Severe: seepage.	Severe: seepage, wetness.	Severe: seepage.	Fair: too sandy.
51B---------- Egeland	Slight----------	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: seepage.
53---------- Wyndmere	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
54---------- Ulen	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
55---------- Hecla	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: wetness, seepage, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
56B---------- Maddock	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
61B---------- Hecla	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: wetness, seepage, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
62B---------- Serden	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy.
64B---------- Towner	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Moderate: wetness, too clayey.	Severe: seepage.	Fair: too clayey, wetness.
65---------- Swenoda	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Moderate: wetness, too clayey.	Severe: seepage.	Fair: too clayey, wetness.
69---------- Arveson	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
71---------- Arveson	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
73---------- Letcher	Severe: wetness.	Severe: seepage.	Severe: seepage, excess sodium.	Severe: seepage.	Poor: excess sodium.
74B*:					
Cresbard----------	Severe: percs slowly.	Moderate: slope.	Severe: excess sodium.	Slight----------	Poor: hard to pack, excess sodium.
Svea----------	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
75*:					
Aberdeen----------	Severe: percs slowly.	Moderate: seepage, wetness.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: excess sodium.
Overly----------	Severe: percs slowly.	Slight----------	Moderate: too clayey.	Slight----------	Poor: thin layer.
79---------- Divide	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
80---------- Marysland	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
82B---------- Arvilla	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
83D---------- Sioux	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
86C---------- Bottineau	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight----------	Fair: too clayey.
86E---------- Bottineau	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
87C---------- Kelvin	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight----------	Poor: too clayey, hard to pack.
87E---------- Kelvin	Severe: percs slowly, slope.	Severe: slope.	Severe: slope, too clayey.	Severe: slope.	Poor: too clayey, hard to pack, slope.
89B---------- Rolla	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight----------	Poor: too clayey, hard to pack.
90E*:					
Bottineau----------	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Buse----------	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
94C---------- Metigoshe	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
94E---------- Metigoshe	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
97*:					
Aberdeen----------	Severe: percs slowly.	Moderate: seepage, wetness.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: excess sodium.
Exline----------	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey, excess sodium.	Severe: wetness.	Poor: too clayey, hard to pack, excess sodium.
100---------- Colvin	Severe: ponding, percs slowly, flooding.	Severe: flooding, ponding.	Severe: ponding, flooding.	Severe: ponding, flooding.	Poor: ponding.
103---------- Eramosh	Severe: ponding.	Severe: excess humus, ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
104---------- Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
110---------- Exline	Severe: wetness, perc slowly.	Severe: wetness.	Severe: wetness, too clayey, excess sodium.	Severe: wetness.	Poor: too clayey, hard to pack, excess sodium.
111---------- Stirum	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, excess sodium.	Severe: seepage, ponding.	Poor: ponding, excess sodium.
116C*: Serden----------	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy.
Hecla---------- Blownout land.	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: wetness, seepage, too sandy.	Severe: seepage, wetness.	Poor: too sandy.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1---------- Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
2---------- Parnell	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
5*. Pits				
6---------- Eramosh	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
10---------- Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
11*: Svea----------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Tonka----------	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
12*, 12B*: Barnes----------	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Svea----------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Tonka----------	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
13, 13B---------- Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
14C*: Barnes----------	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Buse----------	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
15E*: Buse----------	Fair: low strength, slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Barnes----------	Fair: low strength, slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
17*:				
Hamerly	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
19--- Hamerly	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
20--- Hamerly	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salts.
21--- Vallers	Fair: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
25--- Fargo	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
26*:				
Fargo	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Hegne	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
27--- Hegne	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
28--- Hegne	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess salts.
30--- Overly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
31--- Bearden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
33--- Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
34--- Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salts, wetness.
36*:				
Overly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
36*: Great Bend	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
40 Gardena	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
42B Eckman	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
45 Glyndon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
46*: Glyndon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salts.
Bearden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salts.
50 Embden	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
51B Egeland	Good	Probable	Improbable: too sandy.	Good.
53 Wyndmere	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
54 Ulen	Fair: wetness.	Probable	Improbable: too sandy.	Fair: too sandy.
55 Hecla	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
56B Maddock	Good	Probable	Improbable: too sandy.	Poor: thin layer.
61B Hecla	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
62B Serden	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy.
64B Towner	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
65 Swenoda	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
69 Arveson	Fair: wetness.	Probable	Improbable: too sandy.	Fair: small stones, thin layer.
71 Arveson	Poor: wetness.	Probable	Improbable: too sandy.	Poor: wetness.
73 Letcher	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
74B*: Cresbard	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
75*:				
Aberdeen	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Overly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
79 Divide	Fair: wetness.	Probable	Probable	Poor: small stones, area reclaim.
80 Marysland	Fair: wetness.	Probable	Probable	Fair: area reclaim, small stones, thin layer.
82B Arvilla	Good	Probable	Probable	Poor: small stones, area reclaim.
83D Sioux	Good	Probable	Probable	Poor: small stones, area reclaim.
86C Bottineau	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
86E Bottineau	Fair: low strength, slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
87C Kelvin	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
87E Kelvin	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, slope.
89B Rolla	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
90E*:				
Bottineau	Fair: low strength, slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Buse	Fair: low strength, slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
94C Metigoshe	Good	Probable	Probable	Poor: small stones, area reclaim.
94E Metigoshe	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
97*:				
Aberdeen	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
97*: Exline	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
100--- Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
103--- Eramosh	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
104--- Parnell	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
110--- Exline	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
111--- Stirum	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, excess sodium.
116C*: Serden	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy.
Hecla	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Blownout land.				

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
1---------- Tonka	Slight---------	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
2---------- Parnell	Slight---------	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
5*. Pits						
6---------- Eramosh	Moderate: seepage.	Severe: ponding.	Ponding, frost action.	Ponding, soil blowing.	Erodes easily, ponding, soil blowing.	Wetness, erodes easily.
10---------- Svea	Moderate: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
11*: Svea----------	Moderate: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
Tonka----------	Slight---------	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
12*: Barnes----------	Slight---------	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
Svea----------	Moderate: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
Tonka----------	Slight---------	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
12B*: Barnes----------	Moderate: slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
Svea----------	Moderate: slope, seepage.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
Tonka----------	Slight---------	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
13---------- Barnes	Slight---------	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
13B---------- Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
14C*: Barnes----------	Moderate: slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
Buse----------	Moderate: slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
15E*: Buse----------	Severe: slope.	Severe: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
15E*:						
Barnes	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
17*:						
Hamerly	Moderate: seepage.	Severe: piping, wetness.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
Tonka	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
19--- Hamerly	Moderate: seepage.	Severe: piping, wetness.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
20--- Hamerly	Moderate: seepage.	Severe: piping.	Frost action, excess salts.	Wetness, excess salts.	Erodes easily, wetness.	Excess salts, erodes easily.
21--- Vallers	Slight	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
25--- Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
26*:						
Fargo	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, slow intake, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
Hegne	Slight	Severe: ponding.	Ponding, percs slowly.	Ponding; slow intake, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
27--- Hegne	Slight	Severe: hard to pack, wetness.	Percs slowly	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
28--- Hegne	Slight	Severe: wetness, hard to pack.	Percs slowly, excess salts.	Wetness, droughty, slow intake.	Wetness, percs slowly.	Wetness, excess salts, droughty.
30--- Overly	Slight	Severe: piping.	Deep to water	Percs slowly	Favorable	Percs slowly.
31--- Bearden	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Erodes easily, percs slowly.
33--- Colvin	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
34--- Colvin	Moderate: seepage.	Severe: ponding.	Percs slowly, ponding, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, excess salts, percs slowly.
36*:						
Overly	Slight	Severe: piping.	Deep to water	Percs slowly	Favorable	Percs slowly.
Great Bend	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
40--- Gardena	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
42B---------- Eckman	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
45---------- Glyndon	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness--------	Wetness--------	Favorable.
46*: Glyndon----------	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave, excess salts.	Wetness, excess salts.	Wetness--------	Excess salts.
Bearden----------	Moderate: seepage.	Severe: piping.	Deep to water	Excess salts---	Favorable------	Excess salts.
50---------- Embden	Severe: seepage.	Severe: seepage, piping.	Deep to water	Soil blowing---	Soil blowing---	Favorable.
51B---------- Egeland	Severe: seepage.	Severe: piping, seepage.	Deep to water	Soil blowing, slope, droughty.	Soil blowing, too sandy.	Droughty.
53---------- Wyndmere	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Favorable.
54---------- Ulen	Severe: seepage.	Severe: seepage, piping.	Cutbanks cave	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Favorable.
55---------- Hecla	Severe: seepage.	Severe: seepage, piping.	Deep to water	Fast intake, soil blowing, droughty.	Too sandy, soil blowing.	Droughty.
56B---------- Maddock	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
61B---------- Hecla	Severe: seepage.	Severe: seepage, piping.	Deep to water	Fast intake, soil blowing, droughty.	Too sandy, soil blowing.	Droughty.
62B---------- Serden	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
64B---------- Towner	Severe: seepage.	Severe: piping.	Deep to water	Droughty, fast intake, soil blowing.	Erodes easily, soil blowing.	Erodes easily, droughty.
65---------- Swenoda	Severe: seepage.	Severe: piping.	Favorable------	Wetness, soil blowing.	Erodes easily, wetness.	Erodes easily.
69---------- Arveson	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness--------	Wetness, too sandy.	Wetness.
71---------- Arveson	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, frost action, cutbanks cave.	Ponding--------	Ponding, too sandy.	Wetness.
73---------- Letcher	Severe: seepage.	Severe: piping, excess sodium.	Deep to water	Percs slowly, excess sodium.	Soil blowing---	Excess sodium, percs slowly.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
74B*:						
Cresbard	Moderate: slope.	Severe: excess sodium.	Deep to water	Percs slowly, slope, excess sodium.	Favorable	Excess sodium, percs slowly.
Svea	Moderate: slope, seepage.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
75*:						
Aberdeen	Moderate: seepage.	Severe: piping, excess sodium.	Deep to water	Percs slowly, excess sodium, excess salts.	Erodes easily	Excess sodium, erodes easily, percs slowly.
Overly	Slight	Severe: piping.	Deep to water	Percs slowly	Favorable	Percs slowly.
79--Divide	Severe: seepage.	Severe: seepage.	Cutbanks cave	Wetness	Wetness, too sandy.	Favorable.
80--Marysland	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness	Wetness, too sandy.	Wetness.
82B--Arvilla	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
83D--Sioux	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, rooting depth, slope.	Too sandy	Droughty, rooting depth.
86C--Bottineau	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
86E--Bottineau	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
87C--Kelvin	Moderate: slope.	Moderate: thin layer, hard to pack.	Deep to water	Slope	Erodes easily	Erodes easily.
87E--Kelvin	Severe: slope.	Moderate: thin layer, hard to pack.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
89B--Rolla	Moderate: slope.	Severe: hard to pack.	Deep to water	Slow intake, percs slowly, slope.	Percs slowly	Percs slowly.
90E*:						
Bottineau	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Buse	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
94C--Metigoshe	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
94E--Metigoshe	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
97*:						
Aberdeen	Moderate: seepage.	Severe: piping, excess sodium.	Deep to water	Percs slowly, excess sodium, excess salts.	Erodes easily	Excess sodium, erodes easily, percs slowly.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
97*:						
Exline	Slight	Severe: excess sodium.	Percs slowly, excess salts, excess sodium.	Percs slowly, excess sodium.	Erodes easily, wetness, percs slowly.	Excess sodium, erodes easily, percs slowly.
100 Colvin	Moderate: seepage.	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly, flooding.	Ponding, percs slowly.	Wetness, percs slowly.
103 Eramosh	Moderate: seepage.	Severe: ponding.	Ponding, frost action.	Ponding, soil blowing.	Erodes easily, ponding, soil blowing.	Wetness, erodes easily.
104 Parnell	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
110 Exline	Slight	Severe: excess sodium.	Percs slowly, excess salts, excess sodium.	Percs slowly, excess sodium.	Erodes easily, wetness, percs slowly.	Excess sodium, erodes easily, percs slowly.
111 Stirum	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, cutbanks cave, excess salts.	Ponding, droughty.	Ponding, too sandy.	Wetness, excess salts, excess sodium.
116C*:						
Serden	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
Hecla	Severe: seepage.	Severe: seepage, piping.	Deep to water	Fast intake, soil blowing, droughty.	Too sandy, soil blowing.	Droughty.
Blownout land.						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
1---------- Tonka	0-20	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-40	5-25
	20-34	Silty clay loam, silty clay.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	34-60	Silty clay loam, clay loam.	CL	A-6, A-7	0-3	100	95-100	90-100	70-90	30-50	10-30
2---------- Parnell	0-10	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-95	40-60	15-30
	10-40	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-100	40-80	20-50
	40-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-100	70-100	30-80	15-50
5*. Pits											
6---------- Eramosh	0-8	Peat, muck-------	Pt	A-8	0	---	---	---	---	---	---
	8-60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	10-30
10---------- Svea	0-11	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	11-32	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	32-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-80	20-50	5-30
11*: Svea----------	0-11	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	11-32	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	32-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-80	20-50	5-30
Tonka----------	0-20	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-40	5-25
	20-34	Silty clay loam, silty clay.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	34-60	Silty clay loam, clay loam.	CL	A-6, A-7	0-3	100	95-100	90-100	70-90	30-50	10-30
12*, 12B*: Barnes----------	0-7	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	85-100	60-90	20-40	5-20
	7-17	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	75-95	55-80	25-40	5-20
	17-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	75-95	55-80	25-40	5-20
Svea----------	0-11	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	11-32	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	32-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-80	20-50	5-30
Tonka----------	0-20	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-40	5-25
	20-34	Silty clay loam, silty clay.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	34-60	Silty clay loam, clay loam.	CL	A-6, A-7	0-3	100	95-100	90-100	70-90	30-50	10-30
13, 13B---------- Barnes	0-7	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	85-100	60-90	20-40	5-20
	7-17	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	75-95	55-80	25-40	5-20
	17-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	75-95	55-80	25-40	5-20

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
14C*:											
Barnes	0-7	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	85-100	60-90	20-40	5-20
	7-17	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	75-95	55-80	25-40	5-20
	17-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	75-95	55-80	25-40	5-20
Buse	0-7	Loam	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	55-80	20-40	3-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	60-80	25-40	5-20
15E*:											
Buse	0-7	Loam	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	55-80	20-40	3-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	60-80	25-40	5-20
Barnes	0-7	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	85-100	60-90	20-40	5-20
	7-17	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	75-95	55-80	25-40	5-20
	17-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	75-95	55-80	25-40	5-20
17*:											
Hamerly	0-7	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-25
	7-13	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	13-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
Tonka	0-20	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-40	5-25
	20-34	Silty clay loam, silty clay.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	34-60	Silty clay loam, clay loam.	CL	A-6, A-7	0-3	100	95-100	90-100	70-90	30-50	10-30
19	0-7	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-25
Hamerly	7-13	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	13-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
20	0-7	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	25-40	5-20
Hamerly	7-13	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	25-45	5-20
	13-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	25-45	5-20
21	0-10	Loam	OL, ML	A-4	0	95-100	90-100	80-90	50-80	30-40	4-10
Vallers	10-23	Clay loam, silty clay loam.	CL	A-6	0	95-100	90-97	80-95	50-80	30-40	11-20
	23-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-97	85-95	60-75	20-40	5-20
25	0-5	Silty clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
Fargo	5-21	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
	21-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
26*:											
Fargo	0-5	Silty clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
	5-21	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
	21-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-45
Hegne	0-7	Silty clay	OH, CH	A-7	0	100	100	95-100	90-98	50-70	11-30
	7-43	Silty clay, clay	CH	A-7	0	100	100	95-100	95-98	50-70	22-40
	43-60	Silty clay, clay	CH	A-7	0	100	100	95-100	95-100	50-75	22-45
27	0-7	Silty clay	CH	A-7	0	100	100	95-100	90-98	50-70	25-40
Hegne	7-43	Silty clay, clay	CH	A-7	0	100	100	95-100	95-98	50-70	25-40
	43-60	Clay, silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	50-70	25-45
28	0-7	Silty clay	OH, CH	A-7	0	100	100	95-100	90-98	50-70	11-30
Hegne	7-43	Silty clay, clay	CH	A-7	0	100	100	95-100	95-98	50-70	22-40
	43-60	Silty clay, clay	CH	A-7	0	100	100	95-100	95-100	50-75	22-45

See footnote at end of table.

ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
30----------	0-17	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-100	30-45	10-25
Overly	17-39	Silty clay loam, silt loam, clay loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
	39-60	Stratified silt loam to silty clay.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
31----------	0-8	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	80-95	25-55	10-30
Bearden	8-17	Silt loam, silty clay loam.	CL, CH	A-6, A-7	0	100	100	90-100	70-95	25-55	10-30
	17-60	Silt loam, silty clay loam, clay loam.	CL, CH	A-6, A-7	0	95-100	95-100	85-100	60-95	25-55	10-30
33----------	0-8	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-95	35-50	15-30
Colvin	8-47	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	10-30
	47-60	Loam, silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	25-50	10-25
34----------	0-8	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-95	30-50	15-30
Colvin	8-60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	20-50	10-30
36*:											
Overly----------	0-17	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-100	30-45	10-25
	17-39	Silty clay loam, silt loam, clay loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
	39-60	Stratified silt loam to silty clay.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
Great Bend------	0-6	Silty clay loam	CL, ML	A-6, A-7	0	100	100	95-100	85-100	35-50	10-25
	6-14	Silt loam, silty clay loam.	CL, ML	A-6, A-7	0	100	100	95-100	85-100	35-50	10-25
	14-28	Silt loam, silty clay loam.	CL, ML	A-6, A-7	0	100	100	95-100	85-100	35-50	10-25
	28-60	Stratified silt loam to silty clay loam.	CL, ML	A-4, A-6, A-7	0	100	100	95-100	85-100	25-50	5-25
40----------	0-9	Silt loam--------	ML	A-4	0	100	100	75-95	60-90	25-40	NP-10
Gardena	9-60	Silt loam, very fine sandy loam, loam.	ML	A-4	0	100	100	75-95	55-90	20-40	NP-10
42B----------	0-6	Silt loam--------	ML	A-4	0	100	100	85-100	60-90	20-40	NP-10
Eckman	6-28	Silt loam, very fine sandy loam.	ML	A-4	0	100	100	85-100	55-90	20-40	NP-10
	28-60	Silt loam, very fine sandy loam, fine sandy loam.	ML, SM	A-4	0	100	100	65-100	40-90	<40	NP-10
45----------	0-8	Silt loam--------	OL, ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
Glyndon	8-60	Silt loam, very fine sandy loam, loam.	ML, CL-ML, CL	A-4	0	100	100	90-100	60-95	20-30	NP-10
46*:											
Glyndon---------	0-8	Silt loam--------	OL, ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	8-60	Silt loam, very fine sandy loam.	ML, CL-ML, CL	A-4	0	100	100	90-100	60-95	20-30	NP-10
Bearden---------	0-8	Silty clay loam	ML, CL, CH	A-6, A-7	0	100	100	95-100	80-95	25-55	10-30
	8-17	Silt loam, silty clay loam.	ML, CL, CH	A-6, A-7	0	100	100	95-100	80-95	25-55	10-30
	17-60	Silt loam, silty clay loam, clay loam.	ML, CL, CH	A-6, A-7	0	95-100	95-100	85-100	60-95	25-55	10-30

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
50----------	0-14	Fine sandy loam	SM, ML, SC	A-2, A-4	0	100	100	60-95	30-65	<35	NP-10
Embden	14-28	Fine sandy loam, sandy loam.	SM	A-2, A-4	0	100	100	60-85	30-50	---	NP
	28-60	Fine sandy loam, sandy loam, loamy fine sand.	SM	A-2, A-4	0	100	100	50-80	15-50	---	NP
51B----------	0-6	Fine sandy loam	SM, SM-SC	A-2, A-4	0	100	95-100	75-100	30-50	<30	NP-7
Egeland	6-60	Sandy loam, fine sandy loam, loam	SM, SM-SC	A-2, A-4	0	95-100	85-100	70-100	15-50	<30	NP-7
53----------	0-7	Fine sandy loam	SM, ML	A-2, A-4	0	100	100	60-80	30-55	---	NP
Wyndmere	7-19	Sandy loam, fine sandy loam.	SM, ML	A-2, A-4	0	100	100	60-80	30-55	---	NP
	19-60	Fine sand, loamy fine sand, fine sandy loam.	SM, ML	A-2, A-4	0	100	100	60-85	20-55	---	NP
54----------	0-13	Loamy fine sand	SM	A-4, A-2	0	100	100	80-100	20-50	<20	NP-4
Ulen	13-24	Loamy fine sand, fine sand.	SM	A-2	0	100	95-100	70-95	12-35	---	NP
	24-60	Fine sand---------	SP-SM, SM	A-3, A-2	0	100	95-100	80-100	5-35	---	NP
55----------	0-14	Loamy fine sand	SM, SM-SC	A-2	0	100	95-100	85-100	12-35	<30	NP-7
Hecla	14-21	Loamy sand, loamy fine sand, fine sand.	SM, SM-SC	A-2	0	100	95-100	85-100	12-35	<30	NP-7
	21-60	Loamy sand, fine sand, loamy fine sand.	SM, SM-SC, SP-SM	A-2	0	100	95-100	85-100	10-35	<30	NP-7
56B----------	0-14	Loamy fine sand	SM	A-2	0	100	100	50-80	15-35	---	NP
Maddock	14-60	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	100	95-100	60-95	5-35	---	NP
61B----------	0-14	Loamy fine sand	SM, SM-SC	A-2	0	100	95-100	85-100	12-35	<30	NP-7
Hecla	14-21	Loamy sand, loamy fine sand, fine sand.	SM, SM-SC	A-2	0	100	95-100	85-100	12-35	<30	NP-7
	21-60	Loamy sand, fine sand, loamy fine sand.	SM, SM-SC, SP-SM	A-2	0	100	95-100	85-100	10-35	<30	NP-7
62B----------	0-2	Loamy fine sand	SM	A-2	0	100	100	65-85	15-25	---	NP
Serden	2-60	Fine sand, sand	SM	A-2	0	100	100	65-85	15-25	---	NP
64B----------	0-9	Loamy fine sand	SM, SM-SC	A-2	0	100	100	50-80	15-35	<25	NP-5
Towner	9-32	Loamy sand, loamy fine sand, fine sand.	SM, SM-SC	A-2	0	100	95-100	50-80	15-35	<25	NP-5
	32-60	Loam, silt loam, silty clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	95-100	85-95	60-80	25-50	5-30
65----------	0-17	Fine sandy loam	SM	A-2, A-4	0	100	95-100	70-100	30-50	20-30	NP-7
Swenoda	17-33	Fine sandy loam, sandy loam.	SM-SC, SM, ML, CL-ML	A-2, A-4	0	100	95-100	60-85	30-55	20-30	NP-10
	33-60	Silt loam, silty clay loam, loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	95-100	75-100	50-95	25-45	5-20
69----------	0-13	Loam----------	OL, ML	A-4	0-1	100	95-100	85-90	50-80	20-40	NP-10
Arveson	13-21	Fine sandy loam, sandy loam, loam.	SM, SM-SC	A-4	0	100	95-100	60-85	35-50	<20	NP-5
	21-60	Fine sand, loamy sand, sand.	SP-SM, SM, SM-SC	A-3, A-2, A-4	0	100	95-100	50-80	5-45	<20	NP-5

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
71---------- Arveson	0-13	Loam----------	OL, ML	A-4	0	100	95-100	85-90	50-80	20-40	NP-10
	13-21	Fine sandy loam, sandy loam, loam.	SM, SM-SC	A-4	0	100	95-100	60-85	35-50	<20	NP-5
	21-60	Fine sand, loamy sand, sand.	SP-SM, SM, SM-SC	A-3, A-2, A-4	0	100	95-100	50-80	5-45	<20	NP-5
73---------- Letcher	0-6	Fine sandy loam	SM, SM-SC	A-4	0	100	100	60-95	35-50	<30	NP-7
	6-9	Sandy loam, fine sandy loam, loamy fine sand.	SM, SM-SC	A-2, A-4	0	100	100	60-95	20-45	<30	NP-7
	9-16	Loam, sandy loam, fine sandy loam.	SM, SC, ML, CL	A-4, A-6, A-2	0	100	100	60-95	30-60	25-40	3-18
	16-60	Sandy loam, fine sandy loam, loamy fine sand.	SM, SC, ML, CL	A-2, A-4, A-6	0	100	95-100	50-95	30-60	25-40	3-18
74B*: Cresbard--------	0-8	Loam----------	ML, CL	A-4, A-6	0	100	100	85-100	60-80	30-40	5-15
	8-13	Clay loam, silty clay, clay.	CL, CH	A-7	0	100	100	90-100	70-90	40-60	15-30
	13-17	Clay loam, silty clay, clay.	CL, CH	A-7	0	100	100	85-100	70-90	40-60	15-30
	17-60	Clay loam, loam	CL, CH, ML	A-6, A-7	0-5	100	100	85-100	60-80	35-55	10-27
Svea----------	0-11	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	11-32	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	32-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-80	20-50	5-30
75*: Aberdeen--------	0-9	Silt loam--------	CL, ML	A-6, A-7, A-4	0	100	100	95-100	90-100	30-45	7-20
	9-19	Silty clay, clay, silty clay loam.	ML, MH	A-7	0	100	100	95-100	90-100	45-75	15-40
	19-31	Silty clay loam	CL, CH, MH, ML	A-6, A-7	0	100	100	95-100	90-100	35-55	15-25
	31-60	Stratified silt loam to silty clay loam.	ML, CL	A-4, A-6	0	100	100	95-100	85-100	25-40	3-15
Overly----------	0-17	Silt loam--------	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	85-100	25-45	5-25
	17-39	Silty clay loam, silt loam, clay loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
	39-60	Stratified silt loam to silty clay.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
79---------- Divide	0-7	Loam----------	CL, CL-ML	A-4, A-6	0	95-100	95-100	85-95	60-85	25-40	5-20
	7-21	Loam, clay loam, gravelly loam.	CL, CL-ML	A-4, A-6	0-3	95-100	80-100	60-90	55-80	20-40	5-20
	21-60	Stratified sand to gravelly sand.	GM, SM, GP-GM, SP-SM	A-1	0-5	25-75	15-65	10-40	5-25	---	NP
80---------- Marysland	0-19	Loam----------	CL	A-6, A-7	0	95-100	95-100	85-95	50-80	30-50	10-25
	19-27	Loam, clay loam, sandy clay loam.	CL, SC	A-6	0	90-100	85-100	80-95	45-80	20-40	10-20
	27-60	Stratified fine sand to gravelly coarse sand.	SP-SM, SM	A-1, A-2, A-3	0	70-95	50-90	35-70	5-20	---	NP
82B---------- Arvilla	0-15	Sandy loam-------	SM, SC, SM-SC	A-2, A-4	0	95-100	90-100	60-80	30-45	10-30	NP-10
	15-60	Gravelly sand, sand.	SP-SM, GP, SP, GP-GM	A-1	0	35-95	25-90	10-50	0-10	---	NP

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
83D----------	0-8	Loam, sandy loam	ML, CL, SM	A-4, A-6	0-5	95-100	85-100	70-90	45-75	30-40	5-15
Sioux	8-60	Gravelly sand, gravelly loamy sand.	GM, GP, SM, SP	A-1	0	25-75	10-60	5-35	0-25	<25	NP-5
86C, 86E----------	0-5	Loam----------	CL	A-6, A-7	0-5	95-100	90-100	85-95	60-75	25-45	15-25
Bottineau	5-28	Clay loam, loam	CL	A-6, A-7	0-5	95-100	90-100	80-100	65-90	35-50	15-25
	28-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	90-100	80-100	65-90	35-50	15-25
87C, 87E----------	0-5	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-75	20-40	5-15
Kelvin	5-41	Clay loam, clay	CL, CH	A-7, A-6	0-5	95-100	90-100	90-100	70-90	35-60	20-35
	41-60	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	90-100	60-80	35-50	20-30
89B----------	0-12	Silty clay-------	CH	A-7	0	100	100	100	95-100	60-70	30-45
Rolla	12-32	Clay----------	CH, MH	A-7	0	100	100	100	95-100	60-80	30-50
	32-60	Clay----------	CH	A-7	0	100	100	100	95-100	60-80	30-50
90E*:											
Bottineau-------	0-5	Loam----------	CL	A-6, A-7	0-5	95-100	90-100	85-95	60-75	25-45	15-25
	5-28	Clay loam, loam	CL	A-6, A-7	0-5	95-100	90-100	80-100	65-90	35-50	15-25
	28-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	90-100	80-100	65-90	35-50	15-25
Buse----------	0-7	Loam----------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	55-80	20-40	3-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	60-80	25-40	5-20
94C, 94E---------	0-8	Coarse sandy loam, loamy coarse sand.	SM	A-2, A-4	0-5	95-100	95-100	50-70	15-40	<15	NP
Metigoshe	8-11	Coarse sandy loam, sandy loam.	SM, SM-SC	A-2	0-5	95-100	95-100	60-70	20-30	15-25	NP-5
	11-60	Gravelly coarse sand, coarse sand, gravelly loamy coarse sand.	SM, GP, SP, GM	A-1	0-5	35-95	25-80	10-50	0-15	---	NP
97*:											
Aberdeen--------	0-9	Silt loam--------	CL, ML	A-6, A-7, A-4	0	100	100	95-100	90-100	30-45	7-20
	9-19	Silty clay, clay, silty clay loam.	ML, MH	A-7	0	100	100	95-100	90-100	45-75	15-40
	19-31	Silty clay loam	CL, CH, MH, ML	A-6, A-7	0	100	100	95-100	90-100	35-55	15-25
	31-60	Stratified silt loam to silty clay loam.	ML, CL	A-4, A-6	0	100	100	95-100	85-100	25-40	3-15
Exline----------	0-3	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-15
	3-23	Clay, silty clay, silty clay loam.	MH, CH, CL	A-7	0	100	100	95-100	75-100	45-90	25-50
	23-39	Silty clay loam, silty clay.	CH, MH	A-7	0	100	100	95-100	85-100	50-80	20-45
	39-60	Stratified silt to clay.	CL, CH	A-7	0	100	100	95-100	85-100	40-95	15-65
100----------	0-8	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-95	35-50	15-30
Colvin	8-47	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	10-30
	47-60	Loam, silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	25-50	10-25
103----------	0-8	Peat, muck-------	Pt	A-8	0	---	---	---	---	---	---
Eramosh	8-60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	10-30

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
104----------	0-10	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-95	40-60	15-30
Parnell	10-40	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-100	40-80	20-50
	40-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-100	70-100	30-80	15-50
110----------	0-3	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-15
Exline	3-23	Clay, silty clay, silty clay loam.	MH, CH, CL	A-7	0	100	100	95-100	75-100	45-90	25-50
	23-39	Silty clay loam, silty clay.	CH, MH	A-7	0	100	100	95-100	85-100	50-80	20-45
	39-60	Stratified silt to clay.	CL, CH	A-7	0	100	100	95-100	85-100	40-95	15-65
111----------	0-10	Fine sandy loam	SM, ML, CL-ML, SM-SC	A-4	0	100	100	70-95	40-75	15-25	NP-5
Stirum	10-28	Loam, fine sandy loam, sandy loam.	SC, CL, ML, SM	A-2, A-4	0	100	100	60-95	30-75	15-30	NP-10
	28-60	Stratified silt loam to loamy sand.	SM, CL, ML, SC	A-2, A-4	0	100	100	50-100	15-90	<30	NP-10
116C*:											
Serden----------	0-2	Loamy fine sand	SM	A-2	0	100	100	65-85	15-25	---	NP
	2-60	Fine sand, sand	SM	A-2	0	100	100	65-85	15-25	---	NP
Hecla----------	0-14	Loamy fine sand	SM, SM-SC	A-2	0	100	95-100	85-100	12-35	<30	NP-7
	14-21	Loamy sand, loamy fine sand, fine sand.	SM, SM-SC	A-2	0	100	95-100	85-100	12-35	<30	NP-7
	21-60	Loamy sand, fine sand, loamy fine sand.	SM, SM-SC, SP-SM	A-2	0	100	95-100	85-100	10-35	<30	NP-7
Blownout land.											

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	Mmhos/cm				
1----------	0-20	0.6-2.0	0.18-0.23	5.6-7.3	<2	Low-------	0.32	5	6
Tonka	20-34	0.06-0.2	0.14-0.19	5.6-7.3	<2	High------	0.43		
	34-60	0.2-0.6	0.14-0.19	5.6-9.0	<2	Moderate	0.43		
2----------	0-10	0.2-0.6	0.18-0.22	6.1-7.8	<2	Moderate	0.28	5	7
Parnell	10-40	0.06-0.2	0.13-0.19	6.6-7.8	<2	High------	0.28		
	40-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High------	0.28		
5*.									
Pits									
6----------	0-8	2.0-6.0	0.35-0.45	6.6-8.4	<2	----------	0.10	5	3
Eramosh	8-60	0.6-2.0	0.16-0.22	7.4-8.4	<2	Moderate	0.43		
10---------	0-11	0.6-2.0	0.20-0.24	5.6-7.8	<2	Low-------	0.28	5	6
Svea	11-32	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	32-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
11*:									
Svea----------	0-11	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low-------	0.28	5	6
	11-32	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	32-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Tonka----------	0-20	0.6-2.0	0.18-0.23	5.6-7.3	<2	Low-------	0.32	5	6
	20-34	0.06-0.2	0.14-0.19	5.6-7.3	<2	High------	0.43		
	34-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate	0.43		
12*, 12B*:									
Barnes----------	0-7	0.6-2.0	0.13-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	7-17	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	17-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		
Svea----------	0-11	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low-------	0.28	5	6
	11-32	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	32-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Tonka----------	0-20	0.6-2.0	0.18-0.23	5.6-7.3	<2	Low-------	0.32	5	6
	20-34	0.06-0.2	0.14-0.19	5.6-7.3	<2	High------	0.43		
	34-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate	0.43		
13, 13B----------	0-7	0.6-2.0	0.13-0.24	6.1-7.8	<2	Low-------	0.28	5	6
Barnes	7-17	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	17-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		
14C*:									
Barnes----------	0-7	0.6-2.0	0.13-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	7-17	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	17-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		
Buse----------	0-7	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
15E*:									
Buse----------	0-7	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Barnes----------	0-7	0.6-2.0	0.13-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	7-17	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	17-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	Mmhos/cm				
17*:									
Hamerly	0-7	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	7-13	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	13-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Tonka	0-20	0.6-2.0	0.18-0.23	5.6-7.3	<2	Low	0.32	5	6
	20-34	0.06-0.2	0.14-0.19	5.6-7.3	<2	High	0.43		
	34-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate	0.43		
19									
Hamerly	0-7	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	7-13	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	13-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
20									
Hamerly	0-7	0.6-2.0	0.12-0.15	7.4-8.4	4-16	Moderate	0.28	5	4L
	7-13	0.6-2.0	0.10-0.13	7.4-8.4	4-16	Moderate	0.28		
	13-60	0.2-0.6	0.10-0.13	7.4-8.4	4-16	Moderate	0.37		
21									
Vallers	0-10	0.6-2.0	0.22-0.24	7.4-8.4	<4	Low	0.28	5	4L
	10-23	0.2-0.6	0.15-0.19	7.9-8.4	<4	Moderate	0.28		
	23-60	0.2-0.6	0.17-0.19	7.4-8.4	<4	Low	0.28		
25									
Fargo	0-5	0.06-0.2	0.15-0.18	6.6-7.8	<2	High	0.32	5	4
	5-21	0.06-0.2	0.14-0.17	6.6-7.8	<2	High	0.32		
	21-60	0.06-0.2	0.14-0.17	7.9-8.4	<2	High	0.32		
26*:									
Fargo	0-5	0.06-0.2	0.15-0.18	6.6-7.8	<2	High	0.32	5	4
	5-21	0.06-0.2	0.14-0.17	6.6-7.8	<2	High	0.32		
	21-60	0.06-0.2	0.14-0.17	7.9-8.4	<2	High	0.32		
Hegne	0-7	0.06-0.2	0.15-0.18	7.4-8.4	<2	High	0.28	5	4
	7-43	0.06-0.2	0.14-0.17	7.4-8.4	<4	High	0.28		
	43-60	<0.06	0.14-0.17	7.4-8.4	<4	High	0.28		
27									
Hegne	0-7	<0.2	0.14-0.17	7.4-8.4	<2	High	0.32	5	4
	7-43	<0.2	0.13-0.16	7.4-8.4	<4	High	0.32		
	43-60	<0.06	0.09-0.16	7.4-8.4	<4	High	0.32		
28									
Hegne	0-7	0.06-0.2	0.10-0.15	7.4-9.0	4-16	High	0.28	5	4
	7-43	0.06-0.2	0.09-0.14	7.4-9.0	4-16	High	0.28		
	43-60	<0.06	0.07-0.12	7.4-9.0	4-16	High	0.28		
30									
Overly	0-17	0.2-0.6	0.17-0.23	6.6-7.8	<2	Moderate	0.32	5	7
	17-39	0.2-0.6	0.17-0.22	7.4-8.4	<2	Moderate	0.32		
	39-60	0.2-0.6	0.13-0.22	7.9-8.4	<2	Moderate	0.32		
31									
Bearden	0-8	0.2-0.6	0.17-0.23	7.4-8.4	<4	Moderate	0.28	5	4L
	8-17	0.2-2.0	0.16-0.22	7.4-8.4	<8	Moderate	0.28		
	17-60	0.2-0.6	0.16-0.22	7.4-8.4	<8	Moderate	0.43		
33									
Colvin	0-8	0.2-0.6	0.20-0.22	7.4-9.0	<2	Moderate	0.32	5	4L
	8-47	0.06-2.0	0.16-0.20	7.4-9.0	<2	Moderate	0.32		
	47-60	0.2-0.6	0.15-0.20	7.4-9.0	<2	Moderate	0.32		
34									
Colvin	0-8	0.2-0.6	0.13-0.16	7.4-9.0	4-16	Moderate	0.32	5	4L
	8-60	0.2-0.6	0.11-0.15	7.4-9.0	4-16	Moderate	0.32		
36*:									
Overly	0-17	0.2-0.6	0.17-0.23	6.6-7.8	<2	Moderate	0.32	5	7
	17-39	0.2-0.6	0.17-0.22	7.4-8.4	<2	Moderate	0.32		
	39-60	0.2-0.6	0.13-0.22	7.9-8.4	<2	Moderate	0.32		
Great Bend	0-6	0.6-2.0	0.19-0.22	6.1-7.8	<2	Moderate	0.32	5	7
	6-14	0.6-2.0	0.17-0.20	6.6-7.8	<2	Moderate	0.43		
	14-28	0.6-2.0	0.17-0.20	7.4-8.4	<2	Low	0.43		
	28-60	0.2-0.6	0.17-0.20	7.4-9.0	<8	Low	0.43		

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	Mmhos/cm				
40----------	0-9	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	5
Gardena	9-60	0.6-2.0	0.17-0.22	7.4-8.4	<2	Low--------	0.43		
42B----------	0-6	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low--------	0.28	5	5
Eckman	6-28	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low--------	0.43		
	28-60	0.6-2.0	0.14-0.22	7.4-8.4	<2	Low--------	0.43		
45----------	0-8	0.6-2.0	0.20-0.23	7.4-9.0	<4	Low--------	0.28	4	4L
Glyndon	8-60	0.6-2.0	0.17-0.20	7.9-9.0	<4	Low--------	0.28		
46*:									
Glyndon---------	0-8	0.6-2.0	0.13-0.15	7.4-9.0	4-16	Low--------	0.28	4	4L
	8-60	0.6-2.0	0.11-0.13	7.9-9.0	4-16	Low--------	0.28		
Bearden---------	0-8	0.6-2.0	0.14-0.16	7.4-8.4	4-16	Moderate	0.32	5	4L
	8-17	0.06-2.0	0.14-0.16	7.9-8.4	4-16	Moderate	0.32		
	17-60	0.2-0.6	0.11-0.13	7.9-8.4	4-16	Moderate	0.32		
50----------	0-14	2.0-6.0	0.13-0.18	6.6-7.3	<2	Low--------	0.20	5	3
Embden	14-28	2.0-6.0	0.12-0.17	6.6-8.4	<2	Low--------	0.20		
	28-60	2.0-6.0	0.06-0.16	7.9-8.4	<2	Low--------	0.20		
51B----------	0-6	2.0-6.0	0.11-0.17	5.6-7.3	<2	Low--------	0.20	5	3
Egeland	6-60	2.0-6.0	0.09-0.15	6.1-8.4	<2	Low--------	0.20		
53----------	0-7	2.0-6.0	0.13-0.18	7.9-8.4	<2	Low--------	0.20	5	3
Wyndmere	7-19	2.0-6.0	0.12-0.17	7.9-8.4	<2	Low--------	0.20		
	19-60	2.0-6.0	0.06-0.16	7.9-8.4	<2	Low--------	0.20		
54----------	0-13	6.0-20	0.16-0.18	7.9-8.4	<4	Low--------	0.17	4	2
Ulen	13-24	6.0-20	0.10-0.12	7.9-8.4	<4	Low--------	0.17		
	24-60	6.0-20	0.06-0.08	7.9-8.4	<4	Low--------	0.17		
55----------	0-14	2.0-20	0.10-0.12	6.1-7.8	<2	Low--------	0.17	5	2
Hecla	14-21	2.0-20	0.10-0.12	6.1-7.8	<2	Low--------	0.17		
	21-60	6.0-20	0.06-0.13	6.1-8.4	<2	Low--------	0.17		
56B----------	0-14	6.0-20	0.08-0.12	6.6-7.8	<2	Low--------	0.17	5	2
Maddock	14-60	6.0-20	0.05-0.13	6.6-8.4	<2	Low--------	0.17		
61B----------	0-14	2.0-20	0.10-0.12	6.1-7.8	<2	Low--------	0.17	5	2
Hecla	14-21	2.0-20	0.10-0.12	6.1-7.8	<2	Low--------	0.17		
	21-60	6.0-20	0.06-0.13	6.1-8.4	<2	Low--------	0.17		
62B----------	0-2	6.0-20	0.08-0.12	6.1-7.3	<2	Low--------	0.15	5	2
Serden	2-60	6.0-20	0.05-0.07	6.6-7.8	<2	Low--------	0.15		
64B----------	0-9	6.0-20	0.08-0.12	6.6-7.8	<2	Low--------	0.17	5	2
Towner	9-32	6.0-20	0.06-0.13	6.6-7.8	<2	Low--------	0.17		
	32-60	0.2-2.0	0.14-0.22	7.4-8.4	<2	Moderate	0.37		
65----------	0-17	2.0-6.0	0.11-0.17	6.1-7.3	<2	Low--------	0.20	5	3
Swenoda	17-33	2.0-6.0	0.11-0.17	6.6-8.4	<2	Low--------	0.20		
	33-60	0.2-2.0	0.17-0.20	7.4-8.4	<4	Moderate	0.37		
69, 71----------	0-13	2.0-6.0	0.16-0.18	7.4-8.4	<2	Low--------	0.24	4	4L
Arveson	13-21	0.6-6.0	0.15-0.17	7.4-8.4	<2	Low--------	0.24		
	21-60	2.0-6.0	0.05-0.15	7.4-8.4	<2	Low--------	0.17		
73----------	0-6	0.6-2.0	0.11-0.17	5.1-7.8	<2	Low--------	0.24	3	3
Letcher	6-9	0.6-6.0	0.10-0.15	5.1-7.8	<2	Low--------	0.24		
	9-16	0.06-0.2	0.08-0.14	6.6-9.0	2-8	Low--------	0.24		
	16-60	0.6-6.0	0.11-0.18	>7.8	2-8	Low--------	0.24		

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	Mmhos/cm				
74B*:									
Cresbard	0-8	0.6-2.0	0.17-0.20	5.6-7.3	<2	Low	0.32	3	6
	8-13	0.06-0.6	0.11-0.14	5.6-7.3	2-4	High	0.32		
	13-17	0.06-0.6	0.11-0.15	6.1-8.4	2-4	High	0.32		
	17-60	0.2-0.6	0.16-0.20	7.4-9.0	2-8	Moderate	0.32		
Svea	0-11	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low	0.28	5	6
	11-32	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	32-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
75*:									
Aberdeen	0-9	0.6-2.0	0.19-0.22	5.6-7.3	<2	Moderate	0.32	3	6
	9-19	0.06-0.2	0.13-0.19	5.6-8.4	<4	High	0.32		
	19-31	0.06-0.2	0.14-0.17	7.9-9.0	2-8	High	0.43		
	31-60	0.2-2.0	0.14-0.17	7.9-9.0	2-8	Low	0.43		
Overly	0-17	0.2-0.6	0.22-0.24	6.6-7.8	<2	Moderate	0.32	5	6
	17-39	0.2-0.6	0.17-0.22	7.4-8.4	<2	Moderate	0.32		
	39-60	0.2-0.6	0.13-0.22	7.9-8.4	<2	Moderate	0.32		
79	0-7	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low	0.28	4	4L
Divide	7-21	0.6-2.0	0.16-0.19	7.9-8.4	<2	Low	0.28		
	21-60	>20	0.03-0.07	7.9-8.4	<2	Low	0.10		
80	0-19	0.6-2.0	0.17-0.22	7.9-8.4	<2	Moderate	0.28	4	4L
Marysland	19-27	0.6-2.0	0.15-0.19	7.9-8.4	<2	Moderate	0.28		
	27-60	>6.0	0.02-0.07	7.9-8.4	<2	Low	0.15		
82B	0-15	2.0-6.0	0.13-0.15	6.6-7.8	<2	Low	0.20	3	3
Arvilla	15-60	>6.0	0.02-0.05	7.4-8.4	<2	Low	0.10		
83D	0-8	0.6-6.0	0.18-0.20	6.6-8.4	<2	Low	0.28	2	5
Sioux	8-60	>20	0.03-0.06	7.4-8.4	<2	Low	0.10		
86C, 86E	0-5	0.6-2.0	0.20-0.22	6.1-6.5	<2	Moderate	0.28	5	6
Bottineau	5-28	0.6-2.0	0.15-0.19	6.1-7.8	<2	Moderate	0.28		
	28-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
87C, 87E	0-5	0.6-2.0	0.20-0.22	5.6-7.3	<2	Low	0.28	5	6
Kelvin	5-41	0.2-0.6	0.14-0.19	4.5-7.8	<2	Moderate	0.37		
	41-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
89B	0-12	0.06-0.2	0.15-0.18	5.6-7.3	<2	High	0.32	5	4
Rolla	12-32	0.06-0.2	0.13-0.17	6.6-8.4	<2	High	0.32		
	32-60	0.06-0.2	0.13-0.17	7.4-8.4	<2	High	0.32		
90E*:									
Bottineau	0-5	0.6-2.0	0.20-0.22	6.1-6.5	<2	Moderate	0.28	5	6
	5-28	0.6-2.0	0.15-0.19	6.1-7.8	<2	Moderate	0.28		
	28-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Buse	0-7	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
94C, 94E	0-8	2.0-6.0	0.10-0.15	5.6-6.5	<2	Low	0.20	4	3
Metigoshe	8-11	0.6-2.0	0.12-0.14	6.6-7.8	<2	Low	0.28		
	11-60	>20	0.02-0.05	6.6-7.8	<2	Low	0.10		
97*:									
Aberdeen	0-9	0.6-2.0	0.19-0.22	5.6-7.3	<2	Moderate	0.32	3	6
	9-19	0.06-0.2	0.13-0.18	5.6-8.4	<4	High	0.32		
	19-31	0.06-0.2	0.14-0.17	7.9-9.0	2-8	High	0.43		
	31-60	0.2-2.0	0.14-0.17	7.9-9.0	2-8	Low	0.43		

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	Mmhos/cm				
97*:									
Exline----------	0-3	0.6-2.0	0.19-0.22	6.1-7.3	<2	Low-------	0.28	3	6
	3-23	<0.06	0.10-0.15	6.6-9.0	4-16	High------	0.28		
	23-39	0.06-0.2	0.14-0.17	7.9-9.0	4-8	High------	0.43		
	39-60	0.06-0.2	0.14-0.17	7.9-9.0	2-8	Moderate	0.43		
100----------	0-8	0.2-0.6	0.20-0.22	7.4-9.0	<2	Moderate	0.32	5	4L
Colvin	8-47	0.06-2.0	0.16-0.20	7.4-9.0	<2	Moderate	0.32		
	47-60	0.2-0.6	0.15-0.20	7.4-9.0	<2	Moderate	0.32		
103----------	0-8	2.0-6.0	0.35-0.45	6.6-8.4	<2	----------	0.10	5	3
Eramosh	8-60	0.6-2.0	0.15-0.22	7.4-8.4	<2	Moderate	0.43		
104----------	0-10	0.2-0.6	0.18-0.22	6.1-7.8	<2	Moderate	0.28	5	7
Parnell	10-40	0.06-0.2	0.13-0.19	6.6-7.8	<2	High------	0.28		
	40-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High------	0.28		
110----------	0-3	0.6-2.0	0.19-0.22	6.1-7.3	<2	Low-------	0.28	3	6
Exline	3-23	<0.06	0.10-0.15	6.6-9.0	4-16	High------	0.28		
	23-39	0.06-0.2	0.14-0.17	7.9-9.0	4-8	High------	0.43		
	39-60	0.06-0.2	0.14-0.17	7.9-9.0	2-8	Moderate	0.43		
111----------	0-10	0.6-2.0	0.13-0.18	7.9-8.4	2-8	Low-------	0.24	3	4L
Stirum	10-28	0.2-0.6	0.12-0.18	>7.8	2-16	Low-------	0.32		
	28-60	0.6-20	0.06-0.18	>7.8	2-16	Low-------	0.17		
116C*:									
Serden----------	0-2	6.0-20	0.08-0.12	6.1-7.3	<2	Low-------	0.15	5	2
	2-60	6.0-20	0.05-0.07	6.6-7.8	<2	Low-------	0.15		
Hecla----------	0-14	2.0-20	0.10-0.12	6.1-7.8	<2	Low-------	0.17	5	2
	14-21	2.0-20	0.10-0.12	6.1-7.8	<2	Low-------	0.17		
	21-60	6.0-20	0.06-0.13	6.1-8.4	<2	Low-------	0.17		
Blownout land.									

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "brief," "apparent," and "perched" are explained in the text. The symbol > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
1*----- Tonka	C/D	None-----	---	---	+.5-1.0	Apparent	Apr-Jun	High-----	High-----	Low.
2*----- Parnell	C/D	None-----	---	---	+2-2.0	Apparent	Apr-Nov	High-----	High-----	Low.
5. Pits										
6*----- Eramosh	D	None-----	---	---	+2-1.0	Apparent	Apr-Jul	High-----	High-----	Low.
10----- Svea	B	None-----	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High-----	Low.
11: Svea-----	B	None-----	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High-----	Low.
Tonka*-----	C/D	None-----	---	---	+.5-1.0	Apparent	Apr-Jun	High-----	High-----	Low.
12, 12B: Barnes-----	B	None-----	---	---	>6.0	---	---	Moderate	High-----	Low.
Svea-----	B	None-----	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High-----	Low.
Tonka*-----	C/D	None-----	---	---	+.5-1.0	Apparent	Apr-Jun	High-----	High-----	Low.
13, 13B----- Barnes	B	None-----	---	---	>6.0	---	---	Moderate	High-----	Low.
14C: Barnes-----	B	None-----	---	---	>6.0	---	---	Moderate	High-----	Low.
Buse-----	B	None-----	---	---	>6.0	---	---	Moderate	Low------	Low.
15E: Buse-----	B	None-----	---	---	>6.0	---	---	Moderate	Low------	Low.
Barnes-----	B	None-----	---	---	>6.0	---	---	Moderate	High-----	Low.
17: Hamerly-----	C	None-----	---	---	2.0-4.0	Apparent	Apr-Jun	High-----	High-----	Low.
Tonka*-----	C/D	None-----	---	---	+.5-1.0	Apparent	Apr-Jun	High-----	High-----	Low.
19----- Hamerly	C	None-----	---	---	2.0-4.0	Apparent	Apr-Jun	High-----	High-----	Low.
20----- Hamerly	C	None-----	---	---	2.0-4.0	Apparent	Sep-Jun	High-----	High-----	Moderate.
21----- Vallers	C	None-----	---	---	1.0-2.5	Apparent	Nov-Jun	High-----	High-----	Low.
25----- Fargo	D	None-----	---	---	0-3.0	Apparent	Sep-Jun	High-----	High-----	Low.
26*: Fargo-----	D	None-----	---	---	+.5-1.0	Apparent	Jan-Dec	High-----	High-----	Low.
Hegne-----	D	None-----	---	---	+2-1.0	Apparent	Jan-Dec	Moderate	High-----	Low.
27----- Hegne	D	None-----	---	---	1.0-2.5	Apparent	Apr-Jul	Moderate	High-----	Low.

See footnote at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
28---------- Hegne	D	None---------	---	---	1.0-2.5	Apparent	Jan-Dec	Moderate	High-----	Low.
30---------- Overly	C	None---------	---	---	>6.0	---	---	High-----	High-----	Low.
31---------- Bearden	C	None---------	---	---	1.5-2.5	Apparent	Sep-Jun	High-----	High-----	Low.
33---------- Colvin	C	None---------	---	---	0-1.0	Apparent	Apr-Jul	High-----	High-----	Low.
34*---------- Colvin	C	None---------	---	---	+1-2.0	Apparent	Apr-Jul	High-----	High-----	Moderate.
36: Overly----------	C	None---------	---	---	>6.0	---	---	High-----	High-----	Low.
Great Bend-------	B	None---------	---	---	>6.0	---	---	High-----	High-----	Moderate.
40---------- Gardena	B	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	High-----	Moderate	Low.
42B---------- Eckman	B	None---------	---	---	>6.0	---	---	High-----	Moderate	Low.
45---------- Glyndon	B	None---------	---	---	2.5-6.0	Apparent	Apr-Jul	High-----	High-----	Low.
46: Glyndon----------	B	None---------	---	---	2.5-6.0	Apparent	Apr-Jul	High-----	High-----	Moderate.
Bearden----------	C	None---------	---	---	3.0-5.0	Apparent	Sep-Jun	High-----	High-----	Moderate.
50---------- Embden	B	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High-----	Low.
51B---------- Egeland	B	None---------	---	---	>6.0	---	---	Low------	Moderate	Low.
53---------- Wyndmere	B	None---------	---	---	2.0-5.0	Apparent	Sep-Jun	High-----	High-----	Low.
54---------- Ulen	B	None---------	---	---	2.5-6.0	Apparent	Apr-Jul	Moderate	Low------	Low.
55---------- Hecla	A	None---------	---	---	3.0-6.0	Apparent	Apr-Oct	Moderate	Moderate	Low.
56B---------- Maddock	A	None---------	---	---	>6.0	---	---	Low------	Moderate	Low.
61B---------- Hecla	A	None---------	---	---	3.0-6.0	Apparent	Apr-Oct	Moderate	Moderate	Low.
62B---------- Serden	A	None---------	---	---	>6.0	---	---	Low------	Moderate	Low.
64B---------- Towner	B	None---------	---	---	3.0-6.0	Perched	Apr-Jun	Moderate	High-----	Low.
65---------- Swenoda	B	None---------	---	---	2.5-4.0	Perched	Mar-Jun	Moderate	High-----	Moderate.
69---------- Arveson	A/D	None---------	---	---	1.0-2.0	Apparent	Apr-Jul	High-----	High-----	Low.
71*---------- Arveson	A/D	None---------	---	---	+1-1.0	Apparent	Jan-Dec	High-----	High-----	Low.

See footnote at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
73--Letcher	D	None	---	---	3.5-6.0	Perched	Nov-Jun	Moderate	High	Moderate.
74B:										
Cresbard	C	None	---	---	>6.0	---	---	Moderate	High	Moderate.
Svea	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Low.
75:										
Aberdeen	D	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Moderate.
Overly	C	None	---	---	>6.0	---	---	High	High	Low.
79--Divide	B	None	---	---	2.5-5.0	Apparent	Apr-Jun	Moderate	High	Low.
80--Marysland	B/D	None	---	---	1.0-2.5	Apparent	Nov-Jul	High	High	Low.
82B--Arvilla	A	None	---	---	>6.0	---	---	Low	Moderate	Low.
83D--Sioux	A	None	---	---	>6.0	---	---	Low	Low	Low.
86C, 86E--Bottineau	C	None	---	---	>6.0	---	---	Moderate	High	Low.
87C, 87E--Kelvin	C	None	---	---	>6.0	---	---	Moderate	High	Low.
89B--Rolla	C	None	---	---	>6.0	---	---	Moderate	High	Low.
90E:										
Bottineau	C	None	---	---	>6.0	---	---	Moderate	High	Low.
Buse	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
94C, 94E--Metigoshe	B	None	---	---	>6.0	---	---	Low	Moderate	Low.
97:										
Aberdeen	D	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Moderate.
Exline	D	None	---	---	2.5-4.0	Apparent	Apr-Jun	Moderate	High	High.
100*--Colvin	C	Occasional	Brief	Mar-Oct	+1-1.0	Apparent	Apr-Jul	High	High	Low.
103*--Eramosh	D	None	---	---	+2-1.0	Apparent	Jan-Dec	High	High	Low.
104*--Parnell	C/D	None	---	---	+2-2.0	Apparent	Jan-Dec	High	High	Low.
110--Exline	D	None	---	---	2.5-4.0	Apparent	Apr-Jun	Moderate	High	High.
111*--Stirum	B/D	None	---	---	+.5-1.0	Apparent	Apr-Jul	Moderate	High	Moderate.
116C:										
Serden	A	None	---	---	>6.0	---	---	Low	Moderate	Low.
Hecla	A	None	---	---	3.0-6.0	Apparent	Apr-Oct	Moderate	Moderate	Low.
Blownout land.										

* In the "High water table--Depth" column, a plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

TABLE 16.--ENGINEERING INDEX TEST DATA

[Absence of an entry indicates data were not available. The symbol < means less than. NP means nonplastic]

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution							Liquid limit	Plasticity index	Moisture density		Shrinkage		
			Percentage passing sieve--						Percent < .005 mm			Maximum dry density	Optimum moisture	Limit	Linear	Ratio
	AASHTO	Unified	3/4 inch	3/8 inch	No. 4	No. 10	No. 40	No. 200								
										Pct		Lb/ft3	Pct	Pct	Pct	Pct
Barnes loam: (S75ND-009-023)																
B2------ 6 to 17	A-6(10)	CL	100	100	100	100	92	67	33	38	19	115	15	12	0.0	2.0
C2------ 32 to 60	A-6(09)	CL	100	98	95	85	77	58	26	35	19	126	10	13	0.0	1.9
Bearden silty clay loam: (S76ND-009-028)																
C1ca----- 8 to 17	A-7-6(16)	CH	100	100	100	100	98	91	54	51	26	104	19	15	0.0	1.8
C3-------36 to 60	A-6(07)	CL	100	99	99	97	88	64	22	27	10	127	10	15	0.0	1.9
Bottineau loam: (S78ND-009-104)																
B21t----- 3 to 12	A-7-6(12)	CL	100	100	96	91	83	65	35	46	22	103	19	13	0.0	1.9
C1ca---- 12 to 60	A-7-5(11)	CL	100	100	97	93	85	65	33	42	21	109	16	17	0.0	1.8
Eckman silt loam: (S76ND-009-034)																
B3ca---- 11 to 28	A-4(08)	ML	100	100	100	100	100	81	18	32	9	112	15	21	0.0	1.7
C2------ 28 to 60	A-4(08)	ML	100	100	100	100	100	38	14	--	NP	115	14	0.0	0.0	0.0
Egeland fine sandy loam: (S79ND-009-129)																
B22----- 11 to 22	A-2-4(00)	SM	100	100	100	99	92	29	14	--	NP	121	13	0.0	0.0	0.0
C2------ 40 to 60	A-4(02)	SM	100	100	100	100	98	45	12	--	NP	120	12	0.0	0.0	0.0
Exline silt loam: (S76ND-009-026)																
B2t------ 3 to 8	A-7-6(16)	CL	100	100	100	100	97	79	35	48	25	107	18	21	0.0	1.7
C3------ 39 to 60	A-7-5(20)	CH	100	100	100	100	99	97	85	93	61	104	19	17	0.0	1.8
Great Bend silty clay loam: (S76ND-009-044)																
B2------ 6 to 14	A-7-6(13)	CL	100	100	100	100	98	85	40	45	20	110	16	12	0.0	2.0
C2------ 28 to 60	A-6(09)	CL	100	100	100	100	98	94	29	28	13	121	12	21	0.0	1.7
Hecla loamy fine sand: (S75ND-009-010)																
C1------ 21 to 39	A-2-4(00)	SM	100	100	100	100	100	21	8	--	NP	121	12	0.0	0.0	0.0
C2------ 39 to 63	A-2-4(00)	SM	100	100	100	100	100	21	6	--	NP	123	10	0.0	0.0	0.0
Kelvin loam: (S78ND-009-106)																
B21t---- 12 to 39	A-7-6(14)	CL	100	100	100	100	92	70	37	46	25	109	17	12	0.0	2.0
B23t---- 39 to 60	A-7-6(14)	CL	100	100	99	97	92	73	32	43	24	109	16	16	0.0	1.9

TABLE 16.--ENGINEERING INDEX TEST DATA--Continued

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution							Liquid limit	Plasticity index	Moisture density		Shrinkage		
			Percentage passing sieve--						Percent < .005 mm			Maximum dry density	Optimum moisture	Limit	Linear	Ratio
	AASHTO	Unified	3/4 inch	3/8 inch	No. 4	No. 10	No. 40	No. 200								
										Pct		Lb/ft^3	Pct	Pct	Pct	Pct
Metigoshe sandy loam: (S78ND-009-111)																
IIC1---- 12 to 37	A-1-b(00)	GP	--	93	76	53	16	4	1	--	NP	120	13	0.0	0.0	0.0
IIC2---- 37 to 60	A-1-b(00)	GP	--	97	90	75	24	6	1	--	NP	121	12	0.0	0.0	0.0
Overly silty clay loam: (S76ND-009-037)																
B21----- 13 to 39	A-7-6(12)	CL	100	100	100	100	100	86	44	41	20	109	17	13	0.0	1.9
C1ca---- 39 to 70	A-7-6(13)	CL	100	100	100	100	99	97	54	44	19	107	17	22	0.0	1.7
Parnell silty clay loam: (S76ND-009-049)																
B21tg--- 10 to 40	A-7-5(20)	CH	100	100	100	100	100	96	56	60	29	99	21	13	0.0	1.8
C1gca--- 40 to 53	A-7-6(19)	CH	100	100	100	100	100	99	58	57	32	102	19	17	0.0	1.8
Rolla silty clay: (S78ND-009-110)																
B21------ 7 to 30	A-7-5(20)	MH	100	100	100	100	100	98	75	70	34	93	23	14	0.0	1.9
B3ca---- 30 to 60	A-7-5(20)	CH	100	100	100	100	100	100	77	76	44	91	24	18	0.0	1.8

TABLE 17.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Aberdeen	Fine, montmorillonitic Glossic Udic Natriborolls
Arveson	Coarse-loamy, frigid Typic Calciaquolls
Arvilla	Sandy, mixed Udic Haploborolls
Barnes	Fine-loamy, mixed Udic Haploborolls
Bearden	Fine-silty, frigid Aeric Calciaquolls
*Bottineau	Fine-loamy, mixed Udic Argiborolls
Buse	Fine-loamy, mixed Udorthentic Haploborolls
Colvin	Fine-silty, frigid Typic Calciaquolls
*Cresbard	Fine, montmorillonitic Glossic Udic Natriborolls
Divide	Fine-loamy over sandy or sandy-skeletal, frigid Aeric Calciaquolls
Eckman	Coarse-silty, mixed Udic Haploborolls
Egeland	Coarse-loamy, mixed Udic Haploborolls
Embden	Coarse-loamy, mixed Pachic Udic Haploborolls
Eramosh	Fine-silty, mixed (calcareous), frigid Histic Haplaquolls
Exline	Fine, montmorillonitic Leptic Natriborolls
Fargo	Fine, montmorillonitic, frigid Vertic Haplaquolls
Gardena	Coarse-silty, mixed Pachic Udic Haploborolls
Glyndon	Coarse-silty, frigid Aeric Calciaquolls
Great Bend	Fine-silty, mixed Udic Haploborolls
Hamerly	Fine-loamy, frigid Aeric Calciaquolls
Hecla	Sandy, mixed Aquic Haploborolls
Hegne	Fine, frigid Typic Calciaquolls
Kelvin	Fine-loamy, mixed Boralfic Udic Argiborolls
Letcher	Coarse-loamy, mixed Udic Natriborolls
Maddock	Sandy, mixed Udorthentic Haploborolls
Marysland	Fine-loamy over sandy or sandy-skeletal, frigid Typic Calciaquolls
Metigoshe	Coarse-loamy, mixed Boralfic Udic Argiborolls
Overly	Fine-silty, mixed Pachic Udic Haploborolls
Parnell	Fine, montmorillonitic, frigid Typic Argiaquolls
Rolla	Very-fine, montmorillonitic Typic Eutroboralfs
Serden	Mixed, frigid Typic Udipsamments
Sioux	Sandy-skeletal, mixed Udorthentic Haploborolls
Stirum	Coarse-loamy, mixed, frigid Typic Natraquolls
Svea	Fine-loamy, mixed Pachic Udic Haploborolls
Swenoda	Coarse-loamy, mixed Pachic Udic Haploborolls
Tonka	Fine, montmorillonitic, frigid Argiaquic Argialbolls
Towner	Sandy over loamy, mixed Udorthentic Haploborolls
Ulen	Sandy, frigid Aeric Calciaquolls
Vallers	Fine-loamy, frigid Typic Calciaquolls
Wyndmere	Coarse-loamy, frigid Aeric Calciaquolls

* The soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series.

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